JAN 23 1929

QST

DEVOTED ENTIRELY TO

AMATEUR RADIO

PUBLISHED SINCE 1915 BY THE AMERICAN RADIO RELAY LEAGUE INC.

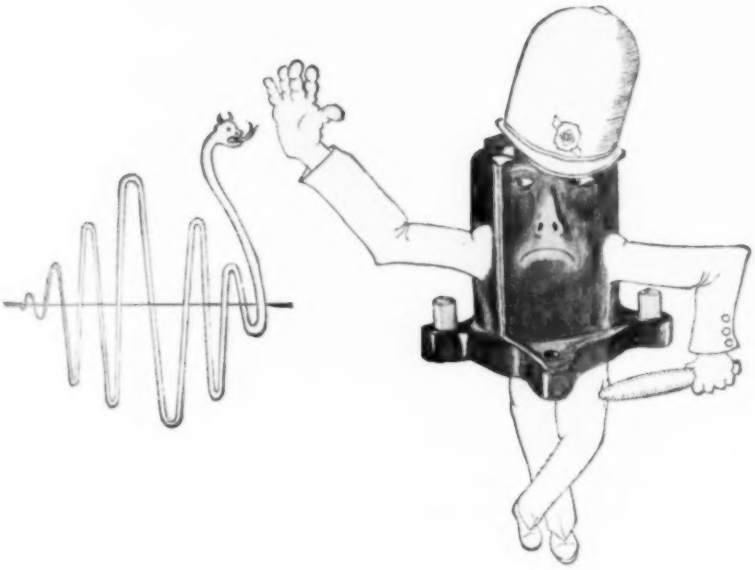
A Double-Detection Receiver *with* Band-Pass Filter *and* Screen-Grid Tubes

in this issue

MARCH 1928

25c

Whoa! Radio Frequency



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QST

The Official Organ of the A·R·R·L

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EDITORIALS

ONE of the grandest little bits of comic radio opera in the whole history of that great art in this country occurred when the Federal Radio Commission held its short-wave hearings in Washington in middle January. It was a sight for gods and men. So many people who knew nothing about radio never before assembled in the same room to talk about it. Gather close, you folks who've been in radio long enough to know your way about, and listen to the nice bedtime story about Uncle Sammy and all the little wavelengths.

Some months ago our Commission wisely deferred action on the growing number of commercial short-wave applications until they could form an estimate of the situation. Publicity on this decision only served to augment the desire. Scores of corporations and industries suddenly became convinced that short waves were necessary to their success and happiness; that with a few hundred dollars, or at most a few thousand, they could build themselves short-wave stations like the amateurs and have unlimited free and rapid private communication, thus saving themselves tens of thousands of dollars annually in tolls to public service companies. There were millions of cycles and therefore waves for everybody. They marched on Washington to demand them at the hearings. The list of industries represented looks like the classified section of the telephone directory. At Washington these people met the interests already entrenched in radio, and the ensuing clash resounded to high heaven. Engineers of the already-established communication companies pointed out the necessity for thinking in terms of channels with definite separation between channels, of the fact that channel width increases as frequency increases; and so they found only a limited number of channels. Counting out those assigned to other services and remembering that the United States can't claim all the waves in the spectrum, these engineers arrived at the conclusion that there were available for fixed stations in this country not more than 170 short-wave channels. As every station would require from two to four different waves, the actual number of stations that could be accommodated was so small and the operating privilege so valuable that there was no hope of making any fair distribution amongst the applicants and the Government ought to confine the assignments to public service companies. Great was the indignation and consternation at this proposal. The newcomers thought they were being tricked. They understood that there were literally tens of thousands of short-wave channels. One by one they arose to state their cases. Most of them admitted they knew nothing technically, didn't know what wavelengths they wanted but they knew they wanted some, and instead of technical statements they engaged in oratory about the public importance of their institutions. The newspapers demanded precedence over the public communication companies, on the basis that newspapers were a more important public institution; a gentleman from the movies expounded at length the great educational force that the films are and how justified they were in having some waves; labor proposed government ownership; a gentleman from the department stores explained their crying need for short waves for the remote control of computing machines (DX bookkeeping) so that the boss could know the day's business promptly.

And so it went. Any amateur would have got a big kick out of the spectacle when he remembered that fateful day in 1912 when he was consigned to the wilderness of useless wavelengths below 200 meters. Then, remembering his gradual taming of shorter and shorter waves, the influx of other services, and the subdividing of the short waves into many narrow bands of which he now retains but a few, he would have been thrilled to pieces to see so many varied interests working so hard to get some of the recently-worthless wavelengths which were once exclusively his. He would know that the amateur had made this scene possible and that this great public interest in his former wavelengths was irrefutable testimony to the wisdom of this Government's policy of freely encouraging amateur radio.

Our Commission has been sadly troubled by the broadcasting problem. In taking up short waves they are about to find out what trouble really is. This is no reflection upon them—they admit they don't know much about short-waves. At the beginning of the hearings they said they had called these meetings to get help; at the end they said that they felt that only divine assistance could aid them. They made no decisions at the hearings, of course, but took everything under advisement. Up to this date no statements of policy have been issued.

These hearings gave us amateurs a splendid demonstration of the strength of our

position by virtue of being recognized in the new International Radiotelegraph Convention. Our 40- and 20-meter bands are specified as amateur, which is to say that if the treaty is ratified by our Senate, as is practically certain, these bands cannot be used for any other purpose. If it were not for this international specification, the width of our bands would be discretionary with the Commission, and in a situation where the current demand for commercial short-waves is at least ten times the available number of channels, we would run a grave risk of being clipped in the "public interest, convenience and necessity". As it is, the Commission may prohibit or restrict amateur radio if it wishes, but it can't use the wavelengths for any other purpose. We have an altogether unique position and it is already clear that it is going to be worth a great deal to us.

Thus the amateur was not primarily concerned with these hearings but the League did embrace the opportunity to get a few short-wave matters off the hook. It asked the Commission to make no reduction in the width of the amateur bands until the end of 1928; it asked that the United States interpret the shared 80- and 160-meter bands as exclusively amateur in this country, except for our old arrangement of sharing our 75-85 meter band with Army mobile stations during daylight hours in the field training season, with Naval aircraft operating offshore, and with Naval vessels at sea working with Naval aircraft; it protested the existence of non-amateur stations working in our bands under amateur calls and asked their removal; and it filed a complaint on the interference situation created in the short-wave field by harmonics from broadcasting stations.

The Commission has a hard row to hoe. Handicapped by lack of technical radio training, their lot is all the more difficult when they find themselves in the intricacies of short waves. Their term of office is almost over. An effort is being made to extend their term another year, an effort to which, for one reason or another, there is little objection. That doesn't insure its success, however; if Congress can't get around to it by March 15th, the Commission becomes an appellate body and relinquishes active administration to the Department of Commerce. But in either event we amateurs have reason for a sense of satisfaction in the knowledge that our specification in the new Convention will relieve us of any great worry in the present public rush for short waves.

IT becomes increasingly apparent that we amateurs are to-day in possession of operating privileges under the new International Radiotelegraph Convention largely because our American delegation could go before the Conference and say that they had had more experience with the administration of radio amateurs than any other nation, that amateurs were law-abiding, that they did not cause trouble, that they were easy to administrate. That ability to say that fine thing was what enabled them to get our privileges.

Officials of our Government have expressed to us the hope that we may continue to merit that endorsement, so that our United States officials may always be able to appear before any investigating body that is considering amateur radio and be able to make that a splendid report of their experience with us.

There are two respects in which such a statement could not be made to-day, two matters in which we are "causing trouble" and which we must clean up at once. One of these is the matter of interference with broadcast reception, which was discussed in detail in our January issue both editorially and in the Communications Department Section. The other is the question of off-wave operation, particularly below our 40-meter band, interfering with Navy operation. This latter subject was also discussed on page v of the Communications Department Section of January *QST*. Even if such off-wave operation were not an outright violation of regulations, surely the splendid friendly support we have received from the Navy Department at the International Conference entitles them to more friendly treatment at our hands than this. We should be ashamed of ourselves. Let us take immediate steps to efface these two blots on our escutcheon, in order that our Government officials may continue to be able to say that we are law-abiding, do not cause trouble, and are easy to administrate.

K. B. W.

Double-Detection Receivers With Band-Pass Filters and Screen-Grid Amplifiers

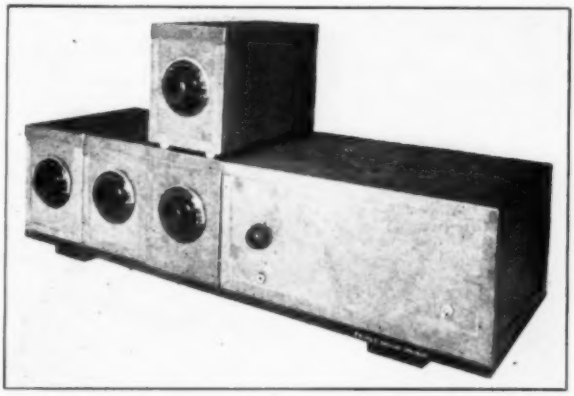
By Dr. Wilfred Taylor*

THE receiver described here suggests a combination of the high amplification of the UX-222, the desirable type of selectivity secured with a band-pass filter and the simplicity of control connected with the double-detection receiver. The reader's first reaction will be that the receiver shown here is a broadcast receiver only, and that it has too many controls. It will be shown, on the contrary, that the receiver may readily be adapted to broadcast reception (200-550 meters), to short-wave telephony, or to c.w. reception. The controls may be reduced to two, without the usual difficulty, since the first circuit does not "run out"; the usual large antenna not being necessary. In the case of the simplified forms suggested later, the problem becomes even simpler since it is necessary to gang but two controls instead of three, and in the c.w. variation suggested by Hull no ganging at all is required. Meanwhile the receiver offers certain advantages not possessed by existing types of commercial receivers.

It has become fairly common practice to use one stage of 201-A in a tuned r.f. amplifier ahead of the so-called "superheterodyne" for broadcast reception. In these cases the purpose is only partly to secure additional amplification, an equally important purpose being to prevent interference with near-by receivers by the oscillator which must necessarily be coupled to the first detector. The use of a "second harmonic oscillator" is another means to the same end but has special disadvantages of its own.

The receiver to be described here is based on an entirely different thought, which is to accomplish most of the amplification with two stages of UX-222 screen-grid tubes working at the received wavelength (that is to say, tuned r.f.) and following this with a band-pass and an intermediate frequency system; principally for the purpose of providing selectivity of a somewhat special sort. The diagram is shown in Figure 1.

One may ask why it would not have been simpler to use the additional control for another stage of r.f. rather than to place it on the oscillator of a double-detection system. The answer to this is that three stages of *well constructed* tuned r.f. with UX-222 tubes is hardly practicable. In the broadcast band it will give an amplification *in excess* of 30,000! This amplification is so high that it is useless even with the smallest antenna because everything that is encountered overloads the system. In addition, 30,000 is a degree of amplification requiring far more selectivity than is provided by the limited number of tuned circuits associated with three stages of r.f.



FRONT VIEW OF THE EXPERIMENTAL DOUBLE-DETECTION BROADCAST RECEIVER

From left to right the copper compartments contain: 1st r.f., 2nd r.f., 1st detector, and in the long compartment: I. F., band-pass, 2nd detector and both audio stages. The upper compartment contains the oscillator. All major stations east of the Mississippi river can be received with good strength on a 2-foot antenna and more than 20 feet of antenna are not usable at night. In spite of this the receiver is unusually quiet in operation.

Two stages of good UX-222 will at all times get one down well below the noise level, and will therefore in effect lift up the background to a degree unknown in the ordinary receiver and necessitate the suppression of that background by a *kind* and *degree* (this distinction will be explained presently) of selectivity not normal in two or three stages of r.f. To provide that selectivity by means of mere sharp tuning is not feasible in either the r.f. or the i.f. In the r.f. position it is obviously not easily done in two stages. In the i.f. it may be possible but would inevitably result in ruining the quality by cutting side-bands;

*Marot Junior College, Dept. of Physics, Thompson, Conn.

a thing about which we hear a lot of nonsense but which *really does happen* when one is driven to extreme selectivity. This

ferent *kind* of selectivity we can obtain usually a higher *degree* of selectivity without (in telephony) cutting sidebands or (in

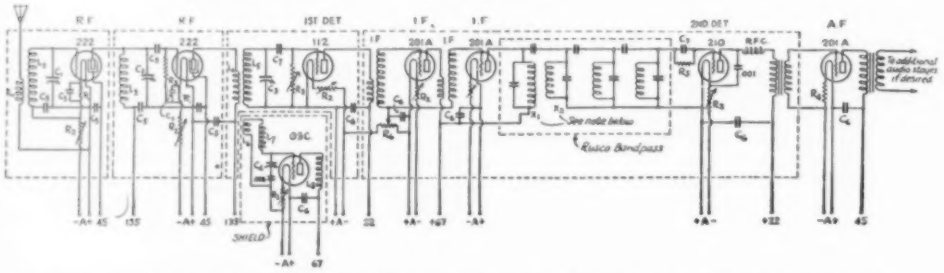


FIG. 1. DIAGRAM OF THE BROADCAST RECEIVER SHOWN IN THE PHOTOGRAPH

Several features of the diagram are due to the experimental nature of the set which has since been rebuilt. Thus the oscillator operates at 67 volts simply because it may be supplied conveniently from the box below, although 22 volts would be sufficient. The variable i.f. grid return has now been made permanent to the battery side (or minus A) of the rheostat. Separate batteries are shown in the diagram but the A battery may obviously be made common and with a little precaution as to chokes and by-passes all of the system beyond the first two tubes may easily be run from the same plate supply. The UX-222 portion of the system requires care if the same thing is to be accomplished. See Fig. 7 for suggestions.

L1—10 turns No. 14 to 20
L2—56 turns No. 20 to 24
L3—56 turns No. 20 to 24
L4—36 turns No. 36 to 40
L5—56 turns No. 20 to 24
L6—3 turns No. 20 to 24
L7—36 turns No. 22
L8—24 turns No. 22
L1 to L6 inclusive wound as solenoids, 3" diameter, any covering
L7 and L8 diamond-weave on same form for oscillator
C5—.006-microfarad Sangamo.
C6—1-microfarad Dubilier paper bypass.
C7—250-μμfd. Sangamo.
R1—10 ohms to give grid bias.
R2—30-ohm rheostat.
R3—Variable 3000 to 500,000, combination bias and gain control.
R4—10 to 15 ohms for grid bias.
R5—Grid leak 2 megohms.
R6—40 ohm potentiometer (may be dropped out)

It is recommended that L3 and C3 be replaced by a pair of coils like L4 and L5. (See Fig. 5)
C1, C2, C3, C4 Cardwell type E, die-cast, tapered-plate, 500-μμfd. tuning condensers.
Points X1 and X2 are joined together via bypass condenser C6 since the A plus lead is common, being grounded to the shield.
RFC—85 millihenry choke of 200 turns small double cotton wire on ¾" spool, 25 turn pies with cardboard separators.

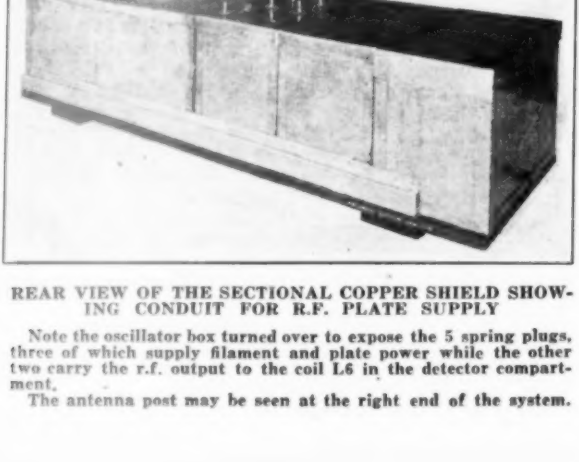
sounds very depressing; almost as if the result demanded is not possible. Fortunately this is not correct, for by going to a dif-

c.w.) causing beat-note signals to become very weak the moment they vary a little as to frequency. What is still more beautiful is that this may be done without adding a single moving part or "tunable" circuit. Figs. 1 and 2 explain this more clearly than much talk.

It, therefore follows, that what is really wanted is a band-pass filter in the intermediate frequency system where it can be made sufficiently complex (see Fig. 3) to have a sharp cut-off and at the same time *transmit a band freely* and without distortion.

To put a band-pass of the type here shown into the r.f. part of the system is out of the question because of the many tuned circuits involved.

The band-pass filter used in the following receivers is relatively an old device and one whose mathematics have been well worked out so that it is somewhat surprising that the device is not more generally used.



REAR VIEW OF THE SECTIONAL COPPER SHIELD SHOWING CONDUIT FOR R.F. PLATE SUPPLY

Note the oscillator box turned over to expose the 5 spring plugs, three of which supply filament and plate power while the other two carry the r.f. output to the coil L6 in the detector compartment.

The antenna post may be seen at the right end of the system.

Especially is it so, as it has long been employed in the identical manner here suggested by the Bell Telephone Laboratories.

The soundness of the idea of an approximately square-cornered cut-off with flat transmission, as opposed to a round-cornered cut-off with peaked transmission is self-evident. The only question that remains

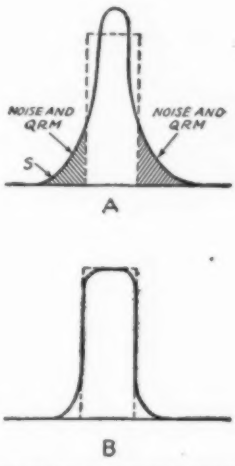


FIG. 2. DIFFERENCE BETWEEN SELECTIVITY OF BAND-PASS AND TUNED CIRCUITS

Tuned circuits give a curve like that of A. (A) Adding more circuits not only cuts down the shoulder at S which is wanted but also cuts down the corners of the desired band shown in dotted line. In telephony this spoils quality and in C. W., signals are lost easily when they swing. (B) A type of selectivity secured by band-pass showing how shoulders are cut away without cutting corners on desired signal.

is, "Can one secure this advantage in practice?" We find that many thousands of band-pass filters of one sort and another are

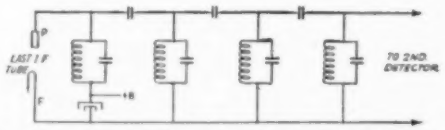
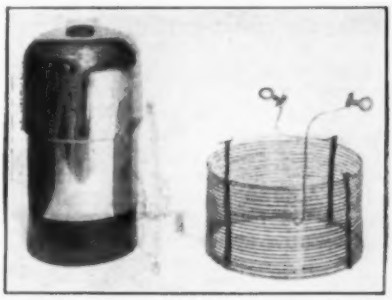


FIG. 3. SIMPLE BAND-PASS SYSTEM FOR APPROXIMATING CURVE OF FIG. 2B

More complex systems can be devised to give more perfect performance. In any case it is better to buy the system ready made.

in standard use in telephone practice at audio frequencies and at intermediate frequencies and are in fact essential for the operation of such things as the transatlantic telephone, the carrier frequency telephone, chain broadcasting, trans-continental telephone and the use of the same wire for several telephone and telegraph conversations, which application makes possible our present long distance communication rates. As to the practical nature of



MODERN LABORATORIES ADJUSTABLE AND CUSHIONED TUBE SHIELD AND A SHORT LENGTH OF SPACE-WOUND COIL OF THE SORT USED IN THE R.F. SYSTEM.

the device, in this case one has but to consider that there exists no other scheme for pushing the background far down while allowing the radiophone signals to come through unimpaired.

For continuous wave reception one naturally needs to pass only a very narrow band so that one automatically thinks of a one or two-kilocycle band-pass. This is not practicable unless one is considering a

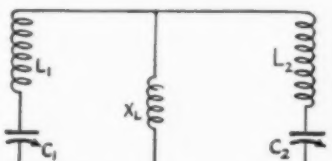


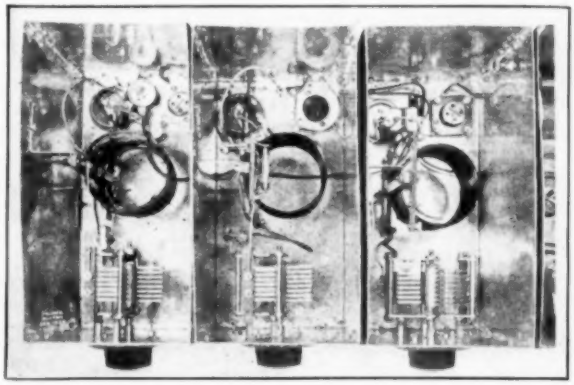
FIG. 4. THIS TYPE OF BAND-PASS CIRCUIT HAS BEEN APPLIED BY F. K. VREELAND TO R.F. SYSTEMS, THE WHOLE THING BEING AT THE WORKING WAVE AND TUNABLE BY GANGING C, AND C, AS MECHANICALLY-CONNECTED VARIABLE CONDENSERS

Even for one stage this requires somewhat careful construction and while commercially possible seems less desirable than the fixed band-pass for other construction. If properly made it functions quite a satisfactory manner, and the ambitious who intend to operate on one band only will find it of advantage.

very few stations which will always appear on the same wavelength. When hunting stations it is highly desirable to be able to hear them even when they are detuned so that the beat note is quite far up the musical scale. It is very disconcerting to use a receiver in which the signal appears suddenly with a pitch of 1000 cycles or thereabouts. The suggestion is therefore that the *same sort* of band-pass (i.e., 10 Kc. wide) be used since it will take off a large portion of the troublesome noisy back-

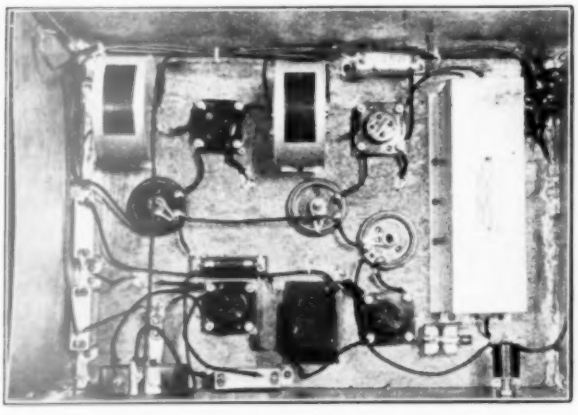
ground, which is not accomplished by the "tone selectivity" found in the normal c.w. receiver. A simplified diagram or the receiver as used for c.w is shown in Figure 3. Adapting the screen-grid tube to the double-detection receiver presents several problems of interest. This tube does not have to be neutralized and it has an enormous amplification factor, both characteristics making it desirable as a radio frequency amplifier. Because of its great sensitivity, it responds readily to all sorts of extraneous electrical disturbances. and for this reason it *must* be most thoroughly shielded. Shielding is of course necessary for another reason, namely that the 222 is screened against *internal* feedback but the usual external feedback must be prevented. Like all sensitive pieces of apparatus, it brings in everything within range, and for this reason circuits using it will be found to tune most broadly. This latter is undesirable, and is very pronounced in the ordinary superheterodyne application.

The tube was tried first on the broadcast band with a set of standard intermediate transformers, and the results were; cross talk, tube noises and mush. I then tried impedance coupling, which was an improvement, but was far from satisfactory. Then a stage of r.f. was put ahead of the first detector, and again the improvement was marked. It occurred to me that if I could get the advantage of the great amplification as an r.f. amplifier and block out cross talk and noise in the intermediate amplifier I should have a working basis for something worth having. Considerable experimenting has inclined me to favor an i.f. transformer which peaks around 100 Kc., so I sent to the Rusco Sales Co. for intermediates which peak at 95 Kc., and their band-pass filter which is built to match them. As there are no B.C. stations (as yet!) just 95 Kc. apart, there is no trouble with oscillator harmonics.



THE 2-STAGE UX-222 TUNED R.F. AMPLIFIER AND FIRST DETECTOR

The coil in the left compartment is the antenna coupler L1-L2, the center one is the tuned impedance L3 and the one at the right is the r.f transformer.



THE 2-STAGE I.F. AMPLIFIER, RUSCO BAND-PASS, 2ND DETECTOR AND AUDIO AMPLIFIER

The large rectangular metal case at the right contains the band-pass. At its forward (lower) end is the 2nd detector and at the lower left in the audio tube.

A preliminary try-out with this combination; a stage of 222 ahead of the first detector and then the ordinary double-detection hook-up using the Rusco outfit, was exceedingly satisfactory. The sensitivity was remarkable, the selectivity above the average and the set was free from any kind of noises. I then tried various coils in the r.f. stage and found that a space-wound coil with a large primary of *very fine* wire wound *in the spaces between* the wires of the secondary, which was suggested by Mr. Kruse, is very much more efficient than any of the usual trap circuits. The overall impedance of this arrangement is better than anything I have seen. This is explained by Fig. 5. I then added another stage of r.f. using an impedance coil, so I could short out either stage (the first stage feeding into the second or into the third or detector coil, and the transformer coupling was much superior as evidenced by the greatly increased volume.) My microammeter has just gone west, so I cannot offer any definite gain-per-stage figures. Using two stages of 222 r.f. gives terrific amplification, but with the "pot"

turned to the "plus" end and one stage detuned the set gives a clarity that is superb. As to the correctness of the band-pass action, one must of necessity quote the log. The first station tuned in was WSB, of Atlanta. Moving the oscillator dial just one mark brought in KFI with enough

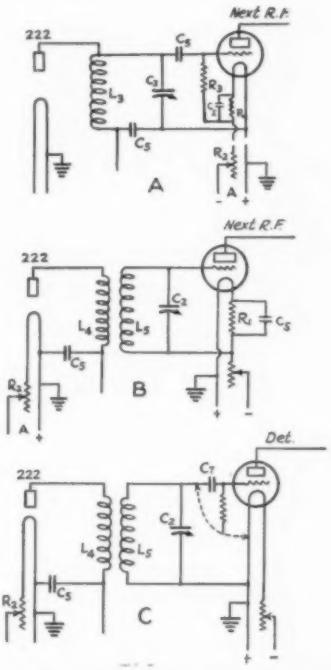


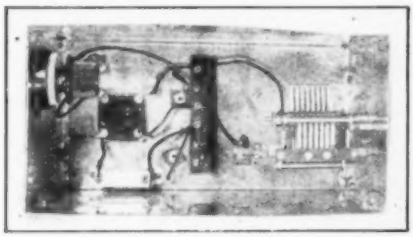
FIG. 5. COMPARISON OF R.F. TRANSFORMER AND TRAP CIRCUIT OR TUNED IMPEDANCE FOR R.F. COUPLING WITH UX-222

Numbers represent same constants as in Fig. 1, otherwise no relation. The ground connection represents the shielding. (A) Tuned impedance necessitating stopping condenser C5 in tuned circuit to avoid grounding B supply, also necessitating placing of leak R-3 direct to filament or else replacing same with resistance (or choke) and bias battery. (B) A transformer coupling permitting grounding of tuning condenser rotor and direct return of grid with less probability of grid going positive and causing partial detection. (C) Same as B but arranged for feeding detector. Alternative positions of grid leak are indicated.

volume to be heard all over the house. They did not interfere. WSB is at 630 Kc. and KFI is at 640 Kc. Again, Frank Palmer near Boston tuned in WEBH, (820 Kc.) and WDAF (810 Kc.) with a one-degree movement of the oscillator dial.

CONSTRUCTION

The shielding is of copper because its conductivity is excellent, also because it is easily worked and may be soldered. Conductivity is the principal feature in a shield, therefore the metal must have sufficient mass to accomplish this thoroughly. Very thin copper is useless, and on the other hand, very thick copper is unnecessary; forty mil stock being about the limit either way. The shield should be sufficiently large to accommodate *without crowding* the various instruments. This size is largely determined by the size of the coils used, because there should be space on all sides of the coil equal to two-thirds of its diameter. Considerable experiment shows



THE OSCILLATOR COMPARTMENT

The Cardwell tuning condenser supports the grid stopping condenser. At the center is a diamond-weave oscillator coil (L7 and L8) of 36 and 24 turns No. 22 on a 15 peg form with a 1½" center. The socket is normally filled by a UX-112.

that a coil three inches in diameter is an optimum dimension. This means that a shield to accommodate it, its condenser, tube rheostat, etc., should be six inches wide, eight inches high, and twelve inches long. The shields shown in the photographs were made by cutting pieces 12" x 22", drawing lines eight inches from both ends and bending on these lines. The bending may be done by laying the sheet on a table which has a fairly square edge, adjusting one of the lines so that it is over the edge, clamping a rigid piece of wood over the copper on the line, and bending with a large hammer or tinsmith's mallet; this process is repeated with the other end. Pieces 6"x 8" are cut and soldered into the ends of the large piece thus making a rectangular box of the dimensions given. The edges are reinforced to secure rigidity by bolting mitered strips to them; these also give the box a finish. The lids are made in the same way.

COILS

Because of the tremendous impedance of the plate circuit of the 222 tube the ordinary radio frequency transformers will not work satisfactorily. I tried several trap (or tuned impedance) circuits and a set of hastily wound intermediates. The results were pathetic. I then wound 56 turns of No. 22 enameled wire on a split tube, tying a knot in each of four pieces of paraffin

impregnated string between each turn. This gives a space-wound coil of excellent characteristics. I then wound thirty turns of No. 36 double-silk wire between the turns of the secondary and used this combination in the ordinary r.f. way. It is far superior to anything I have yet tried. The coils are secured to the shield (grid end up) by means of 2" brass angles, the coils being held by strips of bakelite ½"x7" bolted together as a clamp. The oscillator coil is a diamond-weave affair which gives excellent results and has little field. Three turns of No. 22 enameled wire are clamped in the grid end of the detector coil and connected to the grid coil of the oscillator (in series with the grid coil and the minus A battery side of rheostat). The setting of this rheostat is critical. Instead of putting the oscillator between the first detector and the i.f. amplifier as is usual, I have put it on top of the detector shield so that it is directly connected and none of its wires runs through any other compartment. This is done by using General Radio plugs and jacks.

The i.f. amplifier does not present any unusual features except the band-pass filter. This is an acceptor-rejector circuit consisting of impedance coils and condensers so arranged as to pass exactly 10 Kc. frequency when used with the Rusco transformers. It accomplishes this with remarkable fidelity and without suppressing the side bands requisite to purity of reproduction. It irons out all the tube noises and mush, and makes the use of the 222 a simple matter.

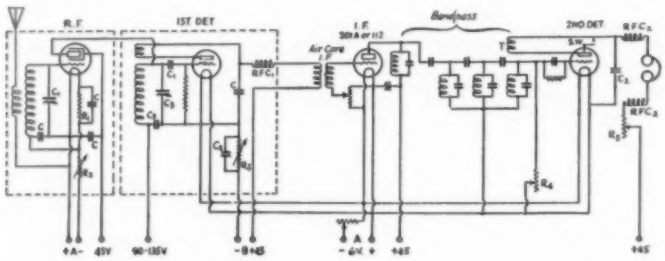


FIG. 6. THE TECHNICAL EDITOR'S SIMPLIFIED VERSION OF THE RECEIVER FOR C.W. WORK

This is in effect a modification of Westman's receiver described in the December issue; a considerable modification because it was by no means so nice a job. The I.F. amplifier was of assorted coils and condensers and too bulky to shield. It is being replaced by the Rusco device. The battery connections differ from Westman's in that the 222 is run from a separate A battery and plate battery, though the screen-grid is tied to the same 45-volt battery which supplied the detector and i.f. amplifier. Curiously enough this has made no trouble, and neither has running the audio amplifier from the same battery. This seems the more peculiar since a previous arrangement like that of Westman's required independent B batteries or filtering of leads after Bourne's style. The dotted boxes represent the limits of the individual shields. Hull's receiver simplifies this by using a 222 in the I.F. and dropping the T.R.F.

C —6,000 μμfd. (.006 μfds.)
C1—100 μμfds. (.0001 μfds.)
C2—.1 μfds.
C3—General Radio "midget" 50 μμfd. variable condenser.
C4—1 μfd.

RFC1 Chokes after Lidbury's specifications.
RFC2 Secondary of Ford spark coil (Model T)
R1—10 ohm fixed resistor
R2—12 ohm rheostat
R3—6 ohm rheostat
R4—500,000 ohm rheostat (Frost)
R5—50,000 ohm rheostat (Frost)

The I.F. control is by means of a potentiometer so that one may use the I.F. oscillating if desired—it compared badly with an oscillating 2nd detector.

The 2nd detector tickler T was coupled back to the last band-pass coil, probably not the best way of doing the thing.

R4 is adjusted to secure apparent proper filter (band-pass) action and R5 controls oscillations of the 2nd detector, whose tickler may be shorted by switch Sw.

In the r.f. stages, the sockets are arranged to shield the tubes. This is done by cutting a square of bakelite the size of the socket base, cutting a copper disc to cover it, and bolting both together with the socket to the shield underneath. A tube shield put out by the Modern Laboratories (Owosso, Mich.) is revamped by putting a bakelite bushing in its top to fit the grid terminal of the 222, and this is slipped over the tube, its bottom resting on the grounded disc. This is *not* a foolish refinement! The tube *will* oscillate if it is not done.

The plate supply for the r.f. tubes is brought from the batteries through a copper trough screwed to the back of the shields; this also acts as a bond between the shields, the whole being soldered to A+ and grounded.

Possibly, the most important thing in the whole arrangement is the bias of the r.f. tubes. Using the Kruse (?) transformer, the biasing is a simple matter; a variable resistor in the grid return. Using an impedance coil the usual leak bias is very inefficient; a single dry cell may be used, but a variable 2000-ohm resistor in the grid return is probably better. This is clarified by Fig. 5.

This is merely a preliminary investigation. Many improvements are yet to be made.

A variety of things have been tried since the original story was written and the photographs made. It has been found that in the broadcast band there is some advantage in using two stages of r.f. amplification. Also, that the three lower controls (input circuits of the r.f. tubes and the first detector) should run amply close together to permit ganging.

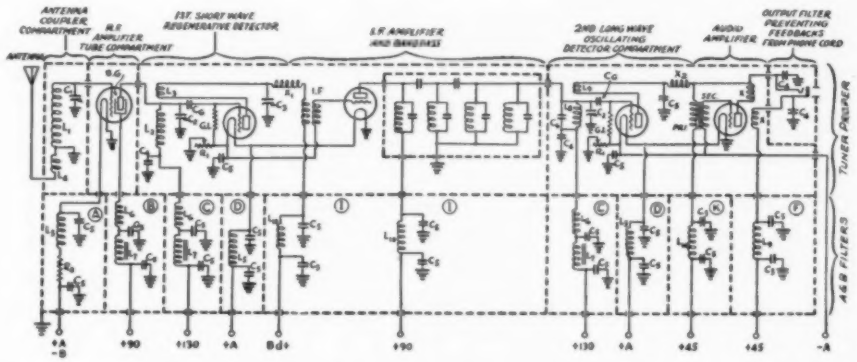


FIG. 7. A SUGGESTED ADAPTION OF R. B. BOURNE'S SHIELDED C.W. RECEIVER BY THE ADDITION OF AN I.F. AMPLIFIER, BAND-PASS AND 2ND OSCILLATING DETECTOR

The heavy dashed line is the copper shielding. In this shielding the upper row of compartments contains the receiver proper while the lower row contains the filters in the different battery lines to prevent interaction between tubes, also to cut down body capacity effects. An additionad filter is found in the upper right compartment. It is connected into the output to the headset to prevent capacity effects from the phone cord. In the actual receiver the "tuner" row of compartments is at the front and the "filter" row is not under the receiver but behind it. Coil dimensions are given in the text of the original article in the December issue, except for L8, L9, X1 and X2, which are given below. The performance of such a receiver will probably not differ greatly from the original except in being quieter in a noisy location and being a little less dependent on the adjustment of C3.

L4 and L1—Antenna coupler or input tuner.

L2 and C2—Tuned circuit acting as plate reactance for the r.f. tube and producing r.f. voltage drop which is fed through the condenser Cg to the detector grid. L2 and C2 thereafter also act as tuned grid circuit for the detector.

L3 and C3—tickler and regeneration control for first detector.

C4—Insulating condensers separating L2 and phone jack from shield to avoid ground on 130- and 45-volt B battery.

AFT—Audio frequency transformer feeding audio amplifier.

X—R.F. chokes separating audio amplifier from detector phones.

X1—R.F. choke separating 1st detector and i.f., ordinary choke suited to working wave.

X2—1000-turn honeycomb coil used as choke to keep i.f. from audio amplifier.

C1—Tuning condenser suited to range and to beliefs of set builder.

C2—Any convenient V.C. (250 μμfds suggested) which will go to 1000 μμfds when shunted by mica condenser C6 as shown. System must tune to i.f., (95 Kc. assumed, therefore about 3150 meters). Do not trust markings on small mica condensers but test range to be sure it is right.

R2—Resistance to lower battery voltage to proper value for the odd filament of the UX-222.

C5—Paper filter condensers.

L5—R.f. filter chokes (Air core).

L7—A.f. filter chokes (Iron core).

L8—300-turn honeycomb or duolateral coil.

L9—150-turn honeycomb or duolateral coil as tickler. Strength of oscillations set permanently by adjusting position of L9 or resistance control may be provided below the filter in compartment K.

L10 in compartments I and K depends somewhat on the i.f. used. 1000-turn honey comb coils are O.K., also ordinary Ford Spark coil secondaries are suitable.

PERFORMANCE

There is no intention here of pointing out the obvious mechanical methods by which

ganging and other commercial simplifications can be accomplished. Before proceeding to the suggested variations of the receiver it may be well to say something of the performance of the broadcast receiver just as it stands.

Two feet of lamp cord attached to the antenna post brought in all the more prominent stations east of the Mississippi River with ample intensity. 20 feet of wire is enough for all ordinary reception and the usual out-door antenna cannot be used except for daylight reception.

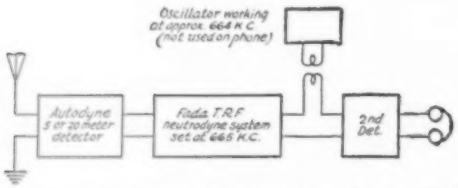

Oscillator working at approx. 664 K.C. (not used on phone)
Autodyne 5 or 20 meter detector
Fada T.R.F. neutrodyne system set at 665 K.C.
2nd Det.

FIG. 8. A SIMPLE WAY TO MAKE UP A TEMPORARY SHORT-WAVE C.W. OR PHONE RECEIVER OF GOOD SENSITIVITY

The short-wave autodyne detector feeds into a neutrodyne system (shielded if possible as in this case), whose output goes to a 2nd detector, possibly the one in the set. An oscillating 2nd detector or a heterodyne is necessary to make a beat note but most signals can be copied on the modulation and for phone it is as well to work purely non-regenerative. As a phone receiver this is a makeshift but for c.w. is not at all bad.

SHORT-WAVE RADIOPHONE VARIATIONS

For short-wave radiophone reception it has been customary to use a regenerative detector and audio amplifier which is not at all satisfactory. This has been done largely because the 201-A is a very poor radio frequency amplifier at short waves (roughly, those below 60 meters). The alternatives are of course; (a), to do the radio frequency amplifying with a UX-222 ahead of a non-regenerative detector, followed by an audio amplifier; or (b), to secure more quiet operation by working the UX-222 into an intermediate frequency amplifier in the manner suggested for the broadcast receiver and, (c) to operate through a first detector and oscillator (without previous amplification) into an i.f. amplifier employing either 201-A or UX-222 tube (or tubes).

System a is satisfactory excepting as to selectivity. There is no opportunity to improve the signal/noise ratio.

System b is the one which has been under discussion and which obviously can be applied to short-wave telephony by changing the size of the tuning coils and condensers. One stage of UX-222 radio frequency amplification can be dropped from the front of the system to decrease the difficulty of the relatively sharp tuning at short waves and the necessary selectivity will still be obtained by means of the bandpass as before The extent to which the device helps the signal/noise ratio must be heard to be appreciated.

System c appears to be a perfectly practical one and with standard tubes has done excellent work. (See *QST*, Jan. 1927, p. 40 and Feb. 1928, p. 41.) But no first hand information on its operation with the UX-222 is at hand.

C.w. variations of system b are shown in Figs. 6 & 7, the labels of which explain them satisfactorily.

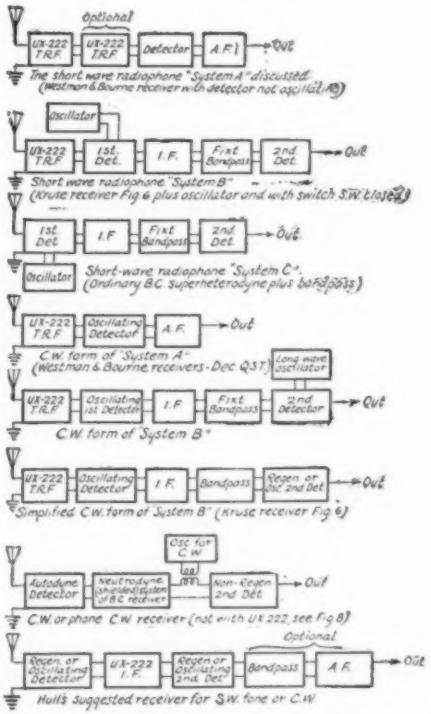


FIG. 9. THE VARIOUS RECEIVER SYSTEMS DISCUSSED

C. W. RECEPTION

For C.w. reception, several possible simplifications are possible. Since one does not want such a high output (headset instead of loudspeaker) one stage of UX-222 r.f. amplifier may be spared in the interest of speed in tuning. Since there is no sideband reproduction to worry about, the heterodyne oscillator can be dropped in

(Continued on Page 31)

Directional Properties of Transmitting and Receiving Antennae*

By J. K. Clapp and Howard A. Chinn**

No short-wave transmitting or receiving amateur can afford to miss this article.—Technical Editor.

A DIRECTIONAL transmitting system is usually thought of as an antenna arrangement which directs a beam of radiation in a given direction in a horizontal plane, or over the earth's surface at the transmitter. The more general definition, however, requires the consideration of antennae having directional properties either in the horizontal plane, the vertical plane or in both and it is from this viewpoint that the various antenna mentioned in this paper are discussed. It should also be kept in mind that the directional properties are equally effective whether the antennae are used for *transmission or reception.*

A single wire vertical antenna, when placed over a perfectly conducting earth and away from all objects that might have an influence upon its natural directional properties, will transmit equally well in all directions in the horizontal plane. That is, it will transmit to the north just as well as to the south, or west, or any other direction. In a practical case it has been found that the energy distribution in the horizontal plane is not always of this simple non-directional character as pictured in Fig. 34a, but may be distorted as shown in Fig. 34b. This shows the approximate distribution of energy of a single vertical wire antenna that was erected at 1XV Round Hills, Massachusetts, midway between two steel towers that were 120 feet high and separated by a distance that corresponds to very nearly one wavelength at 38 meters. It is seen that transmission in the line of towers has been materially decreased and therefore in the actual case the transmission was not equally good in all directions. The distortion of the energy distribution curve is caused by radiation from the towers, which act as antennae. The currents in the towers are practically in phase with the current in the antenna wire midway between them. The result is that the effective radiation in a direction along the line of the towers is decreased, while in a direction at right angles to the line of the towers it is increased. The angle which most of the radiated energy makes with the earth depends upon the height of the antenna above the earth, the character of the earth and the length of the antenna wire.

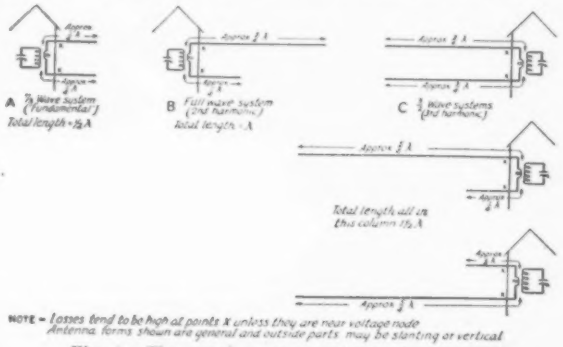

A
B
C
Total length all in this column = λ
NOTE – Losses tend to be high at points X unless they are near voltage node
Antenna forms shown are general and outside parts may be slanting or vertical

Fig. 1.—The usual amateur antenna for transmission is a straight or bent Hertzian antenna, usually called an "antenna-counterpoise system", with more or less of some low-voltage part of the system brought into the station for coupling to the set. Usually the system does not include much loaded.

For transmission to particular points or to overcome a bad location it is desirable to consider replacing such a simple system by one of the various types described later. The "approximate" lengths are given only to suggest which low-voltage point is in the station. The important thing is the overall length.

In the study of horizontal antennae it is found that the energy distribution in a horizontal plane is not symmetrical with respect to a perpendicular at the center of the antenna system, but that most of the energy is radiated at right angles to the antenna and therefore transmission is usually found to be best in this direction.

The energy distribution in a vertical plane depends on the character of the earth, the height of the horizontal wire above earth, the length of the wire and the direction which the antenna makes with the plane considered. At certain heights, i.e., 0, $\lambda/2$, λ etc., the vertical radiation is zero, while at other heights, $\lambda/4$, $3\lambda/4$ etc., the vertical radiation is a maximum.

Multiple antenna systems which direct a beam of energy in a given direction over

*Contribution from Colonel E. H. R. Green Research.

** Electrical Communication Laboratory, Massachusetts Institute of Technology, Cambridge, A. Massachusetts.

the earth's surface are readily arranged, and *at wavelengths of forty meters or less they do not present any great mechanical difficulties in construction.* They do not require an unreasonable amount of space unless it is desired to construct a system

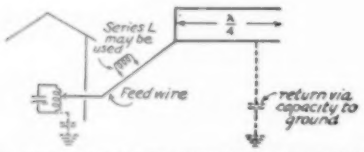


FIG. 2. THE SIMPLEST METHOD OF REMOVING THE ANTENNA FROM THE STATION IS TO FEED IT THROUGH A 1-WIRE FEEDER OR TRANSMISSION LINE

The antenna may be bent as shown or straight, as is quite common. The feeder length is usually about 1/10 wavelength unless series L or C be used. The defects of this method of voltage feed are discussed in the text.

producing an extremely well-defined beam.

Systems consisting of a number of vertical wires in the same plane, properly spaced and so excited that the currents

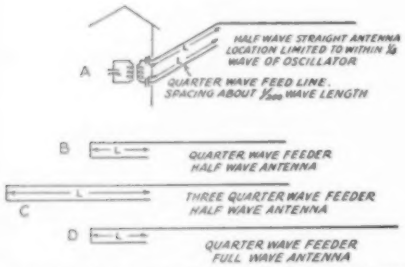

A
HALF WAVE STRAIGHT ANTENNA LOCATION LIMITED TO WITHIN ½ WAVE OF OSCILLATOR
QUARTER WAVE FEED LINE. SPACING ABOUT 1/500 WAVE LENGTH
B
QUARTER WAVE FEEDER HALF WAVE ANTENNA
C
THREE QUARTER WAVE FEEDER HALF WAVE ANTENNA
D
QUARTER WAVE FEEDER FULL WAVE ANTENNA

FIG. 3. VOLTAGE FEED BY MEANS OF A NON-RADIATING 2-WIRE LINE

If vibration of the type shown in Fig. 5 is prevented as suggested in Fig. 6 or by stiff conductors this method has advantages over the one of Fig. 2.

are in phase, have very marked directional properties providing the dimensions of the system are large compared with the wavelength. Even if the dimensions of the system are of the same order as the wavelength, the directional properties are quite noticeable and well worth the consideration of the progressive amateur.

THE WORK AT 1XV AND 1BYX

In order to contrast the theoretical with the actual directional properties of the various antenna arrangements that are discussed, many of the systems have been erected and tested during the past two years at Round Hills (1XV) and Auburndale (1BYX) both in Massachusetts.

The first type of antenna investigated was the usual "antenna-counterpoise" system, which is extensively used by amateurs. This type of antenna is also known as the "quarter-wave transmission line type" or bent Hertzian antenna, and consists simply of two wires, about a quarter of a wavelength in length, one above the other and separated by six to twenty feet or more. This antenna is shown in Fig. 1A and for simplicity the usual antenna and counterpoise condensers have been omitted from the sketch. The antenna is

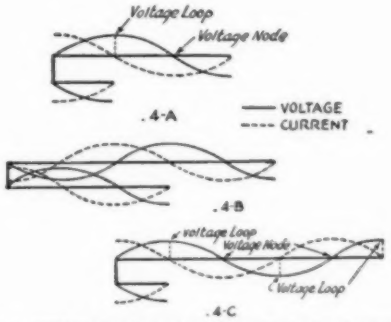


FIG. 4. VOLTAGE DISTRIBUTION AND CURRENT DISTRIBUTION FOR THE SYSTEMS OF FIG. 3

fairly effective but has two disadvantages. The first is that the wires connecting the two antenna wires must generally be brought within the station building thereby introducing undesirable losses into the antenna system because of the walls of the building. The second is that the structure cannot be elevated appreciably above surrounding objects because the dimensions would then become too great for satisfactory operation at the desired wavelength. This latter objection is overcome to a certain extent by the single-wire-transmission-line type of feeder, (Fig. 2) which permits the placing of the antenna circuit proper at nearly any desired location, energy being

FIG. 5. INCORRECT STRUCTURE LEADING TO VIBRATIONS OF WIRES RELATIVE TO EACH OTHER

transferred from the transmitting oscillator via the single transmission line *and the capacitance of the antenna system to ground.*[1] The method just outlined is *not*

1. Methods of laying out and adjusting such system are given in detail on page 11, July 1926. (L. G. Windom.)—Tech. Ed.

simple in adjustment and the antenna system is in itself practically a fixed wavelength arrangement, resulting in a marked lack of flexibility, when properly operated. Many stations using this system unknowingly operate the feed-line as a lead-in, using the entire structure as an antenna, which is far from desirable. It should be realized that the antenna of Fig. 2 is exactly equivalent to that of Fig. 1 with the exception that in one case the energy is brought to the antenna through a feed wire while in the other case it is coupled directly into the system. Inasmuch as the losses of a feeder system can usually be made less than those of a coupled-antenna arrangement it has been found advisable to employ some form of feeder arrangement whenever feasible.[2]

FIG. 6. CORRECTION OF FIG. 5 BY USE OF LIGHT SPACERS

Wires do not swing relative to each other, but together. Stiff conductors will also effect a curve.

The second type of antenna consists of a *two-wire transmission* line feeding a straight wire (Fig. 3) which acts as the antenna system (sometimes referred to as the "Zeppelin" antenna since it was first suggested to be hung from dirigible balloons). The antenna wire is cut to one-half of the desired wavelength[3] in length and may be placed in any location or position, as desired, or as may be dictated by local conditions at the transmitter. The two-wire transmission line is preferably one-quarter wavelength long, but may be made any *odd number of quarter wavelengths* with essentially the same results. It must be realized, however, that this two-wire feeder cannot be any length that is convenient but *must bear a definite relation to the designed operating wavelength of the antenna.*[4] The reason for this is clearly evident upon consideration of the voltage and current distribution on the line as illustrated in Fig. 4. The case of the quarter-wave feeder and half-wave antenna is shown in Fig. 4a. The antenna and feeder are shown in a horizontal position but it is realized that the antenna may be placed in any position at all and the feeder bent in whatever manner is necessary to reach the driving oscillator. The feeder wires may be brought around corners, placed in a horizontal or vertical plane or arranged in any other way desired. From the figure it is seen that the half-wave antenna is operated in the usual manner with a current loop at the center and voltage loops at the ends. The system is so arranged that the currents in the feeders are exactly out of phase and therefore *the radiation from the feeder is practically zero.* Tests on a carefully adjusted system have verified these conclusions. The current and voltage distribution curves for the three-quarter wave feeder and half-wave antenna are shown in Fig. 4b and for the quarter-wave feeder, full-wave antenna in Fig. 4c. It is quite apparent from these figures that the feeder *must* be a quarter-wave long or an odd multiple thereof.[4]

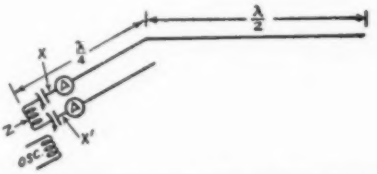


FIG. 7. THE INPUT END OF THE 2-WIRE VOLTAGE-FEED SYSTEM OF FIGS. 3-6

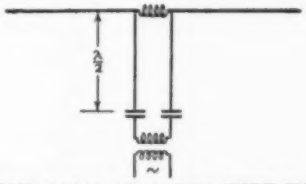


FIG. 8. ONE FORM OF A TWO-WIRE VOLTAGE-FEED SYSTEM

The feeder wires in this case are each one-quarter wavelength long, or even multiple of that length.

Many variations are possible, especially as to the apparatus at the top of the feeder and the form of the antenna, which may be bent like that of Fig. 2 or in any other manner desired. In place of the coil shown at the top of the feeder line a condenser or a more complex system may be used, or finally the line may be left open (nothing connected across) and simply connected to the two sides of the antennt. It is not discussed here because it has previously been covered in QST, also because the authors are not convinced of its desirability in view of the rather poor match between the antenna and line impedances. The same disadvantage does not apply to the system here shown or the other arrangements using such adapting devices as have just been suggested.

2. The length to which antenna system is to be cut may be determined from p. 46, May, 1926, (J. M. C.+H. P. W.) or from p. 30, August, 1926. (Benjamin S. Melton).—Tech. Ed.

3. The wavelength in meters multiplied by 3.28 gives the wavelength in feet. For instance: a 40-meter, half-wave antenna would be ½×40×3.28 = 65.6 feet long.—Authors.

4. The same restriction does not apply to methods where the line terminates in special apparatus, as will be shown later. These methods usually relate to current feed of the antenna, rather than voltage feed. —Tech. Ed.

At the oscillator end of the transmission line, adjustable coupling may be provided in the form of a coupling coil and a variable condenser either in series or parallel with the coil, so that the voltage loop appearing near the far end of the transmission line may be shifted along the line in order that a maximum voltage may be impressed upon the antenna system. This arrangement has the advantage that the *radiation of a two-wire transmission line (Fig. 3) is practically nil, as compared to the relatively large radiation that exists from a single-wire feeder which really acts as an ordinary antenna.*

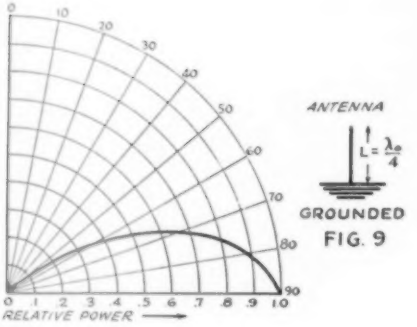


FIG. 9

In the case of the single-wire feeder which is short compared with the wavelength, the current distribution is practically uniform along the entire length of the feeder and it radiates just as much as the portion which is usually thought of as the antenna proper. If the single-wire feeder is long compared to the wavelength standing waves are set up on the line, just as they are on the antenna itself, and the entire system acts as a radiator. When using the two-wire transmission line, the radiation from one wire practically neutralizes that of the other and we have very little resultant radiation. It is found that 85 percent of the energy is confined about the wires within a circle whose diameter is equal to four times the separation of the wires. Therefore, with this arrangement we are certain that practically all our radiation is coming from our antenna proper. The two-wire transmission line has the further advantages that there is no need of carefully determining the point at which the feeder is attached to the antenna, it being placed at a point corresponding to a voltage loop;[5] it is more flexible and is easier to adjust than the single-wire transmission line system; the antenna structure is cut to exact dimensions determined by the wavelength desired—no empirical constants need to be used and the losses caused by the feeders going through the wall are a minimum since a voltage node

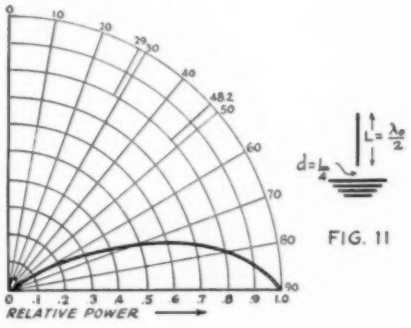


FIG. 11

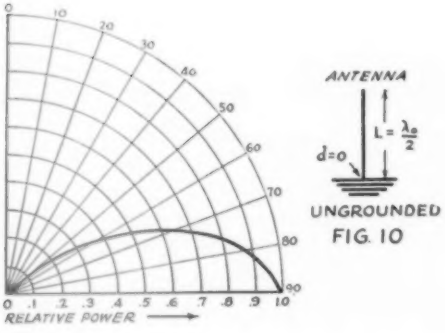


FIG. 10

(mentioned in more detail below) exists on the transmission line at this point. From Fig. 4 we see that a current loop occurs at the tuning condensers when *the system is properly adjusted* and therefore if we place an ammeter at this point we have a means of determining the proper adjustment.

Various antenna systems as described were constructed at the experimental station 1XV at Round Hills, and many adjustments of the antenna wires and feeders made, the resulting antenna current being observed at the center of the antenna and at the transmitter end of the transmission line. Particular tests were made on feeder lines one-quarter and three-quarter wavelengths long in an effort to determine the possible effect of attenuation along the transmission line. No observable difference in antenna current was noted for the two lengths of the transmission line, indicating that if attenuation takes place on the line, it is of no practical importance

5. See Fig. 4 for location of the voltage loops.—Authors.

insofar as building up a reasonable amount of current in the antenna wire is concerned. The effect of a change in spacing of the transmission line wires was also found to have little influence upon the antenna current. Spacings varying from 6 to 24 inches were used.

In the construction of two-wire transmission lines extreme care must be taken that the individual wires do not tend to swing, relative to one another. If glass

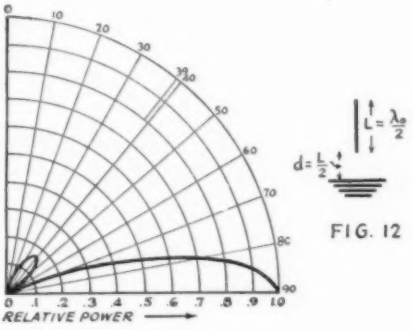


FIG. 12

tooth-brush holders are used for separators it will be found that the wires will swing relative to each other and the heavy separators will remain stationary, see Fig. 5. This will cause detuning and resultant swinging of the transmitted signals. To overcome this, separation made of ⅜-inch woden dowels, boiled in paraffin has been used and it has been found that the feeder swings as a unit, (Fig. 6) and as a result the spacing between wires does not change, and the signals are steady even in the high winds that have been encountered along the Atlantic coast.

In these systems, it is very convenient from a practical viewpoint, to be able to cut the antenna and feeder wires to the correct length with the assurance that good performance will be obtained at the desired wavelength. At first, it seemed that no definite relationship could be predicted between the length to which the wire was cut and the wavelength of best operation of the antenna when installed. Later developments showed that most of the discrepancy was due to a shifting voltage nodal point at the transmitter end of the transmission line, with varying adjustments of the antenna and transmitting circuits. By arranging a variable condenser in each of the feed lines, the position of the node could be readily controlled, and if it were brought to the midpoint of the coupling inductance, the results obtained with the antenna system were closely predictable from the dimensions of the system. That

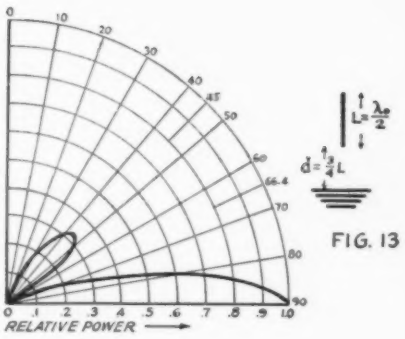


FIG. 13

is, if the antenna was cut one-half wavelength long, the feeder one-quarter wavelength or odd multiple thereof, then with a balanced nodal point, very good performance was obtained at the calculated wavelength. A considerable latitude is experienced in the wavelength at which the system operates well, a variation of wavelength of 10%, above or below the designed wavelength having been found possible with practical antenna efficiency.

A test for the location of the voltage node

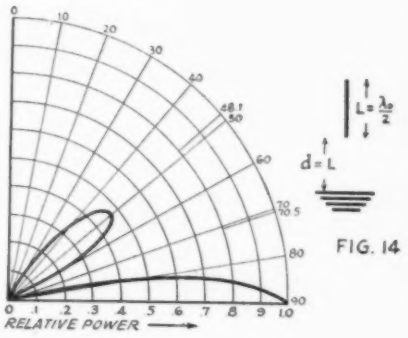


FIG. 14

on the antenna tuning coil or along the transmission line is easily made by touching a screw driver, or other insulated piece of metal, to the various turns of the coil or along the wire. At the node no spark will be obtained.

If the feed line is slightly less than a quarter-wavelength long, then the point of maximum voltage may be moved along the line by shunting a small condenser across the oscillator end of the transmission line. The addition of this small capacitance brings the maximum voltage point "in over the end of the line". Proper adjustment of the condenser permits an increase of antenna current, with short feeder line, of as much as 10 percent. If the line is slightly

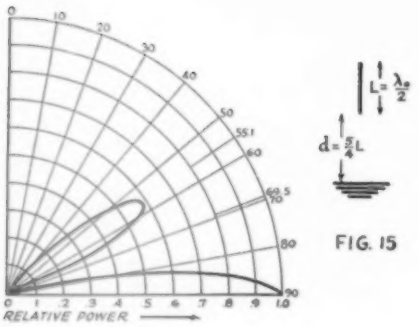


FIG. 15

more than one-quarter wavelength long, the shunt capacitance is not used, the necessary adjustments being made by means of the two series condensers whose purpose is to balance the nodal point. The flexibility thus obtained is such that very good operation may be obtained even though the transmission line is slightly different in length as compared with the desired quarter wavelength.

The arrangement that has been found most satisfactory for voltage feed is shown in Fig. 7. The values of the condensers, and inductance should be such that if the system were shorted at XX' the closed circuit consisting of the tuning condensers and the antenna inductance would tune to the operating wavelength. Tests for voltage nodes should be made at the points X, X', and Z and the condensers adjusted until nodes appear at these points. When this adjustment is obtained it will be found possible to place the fingers between the points X and X' (there being no voltage to cause a burn) without affecting the operation or frequency of the transmitter in any way. The above remarks apply equally well to the case of a three-quarter wavelength transmission line.

In the experiments carried out, the current-feed system was tried only to the extent necessary to establish the fact that it would operate the antenna in the same manner as the voltage-feed system described. *There is no particular reason why one system should have any advantage over the other, when both are used at their optimmum adjustments.* The arrangement used is indicated in Fig. 8, half-wave feeder being used to obtain a maximum current at the antenna loading coil.[6] The reactance drop in the coil is impressed at the center of the antenna system and the antenna current being measured just 'out-

FIG. 16. DIAGRAM TO EXPLAIN APPLICATION OF CURVES OF FIGS. 9-15 TO HORIZONTAL ANTENNAS

side" of the loading coil. With proper adjustment the antenna current was found to be exactly the same as that obtained with the voltage-feed system, but from an operating standpoint, this system is not so desirable as the voltage-feed system because of the necessity of placing a coil or a condenser at the center of the antenna, so that the latter system was employed in all later experiments.

These systems of exciting the antenna

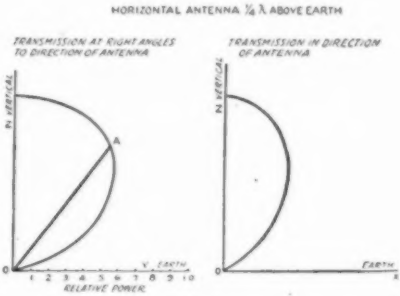

HORIZONTAL ANTENNA ¼ λ ABOVE EARTH
TRANSMISSION AT RIGHT ANGLES TO DIRECTION OF ANTENNA
TRANSMISSION IN DIRECTION OF ANTENNA
N. VERTICAL
A
V. EARTH
EARTH
0 1 2 3 4 5 6 7 8 9 10
RELATIVE POWER

FIG. 17

lend themselves very well to the excitation of two or more antennae, with the maintenance of definite phase relationships between the currents in the various antennae, and are therefore of great value when constructing a directional antenna system.

As transmission by short waves is be-

6. By making special provisions for matching the line to the loads at both ends this limitation may be avoided. One method of doing this is described on page 43, January, 1928. (Walter Van B. Roberts.)—Tech. Ed.

lieved to be largely dependent upon the bending of the waves in the upper regions of the atmosphere for transmission over great distances, it would appear to be very advantageous to utilize a directive system

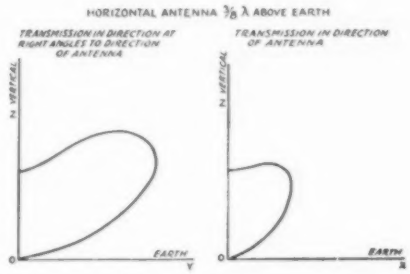


FIG. 18

such that the maximum intensity of radiation is obtained in a direction favorable for refraction in the upper atmosphere. Practical operating results indicate that for a transmitter to be effective at great distances on short wavelengths, the antenna system employed must be of such a type as to have a strong component of radiation in the horizontal direction, that is, tangent to the earth's surface at the transmitter. For shorter distances the strong component must be at greater and greater angles with the horizontal as the distance of trans-

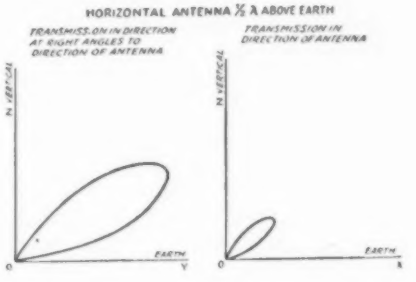


FIG. 19

mission becomes less. However, for general communication purposes, it is desirable to have an antenna which will transmit equally well in all the directions in the horizontal plane. That is, if we were to move around the antenna, in a circle on the ground with field strength measuring apparatus we should find equal field strengths at all points on the circle. If it were desired to communicate primarily with stations at great distances, then the characteristics of the antenna in the vertical plane should be such as to give as intense radiation as possible at the angles which are most suitable for such transmission; for short distances the antenna should radiate most intensely at relatively high angles, of the order of 45 to 70 degrees. Recent experimental results due to Meissner in Germany indicate that very high angle radiation may play a very important role in long distance communication. Transmission from Nauen to Argentina has been maintained on 11 meters, using reflectors sending the main beam of radiation up at angles of from 30 to 80 degrees from the horizontal at the transmitter. *Horizontal antennae would play an important part in amateur radio if transmission by high-angle radiation is to be followed.*

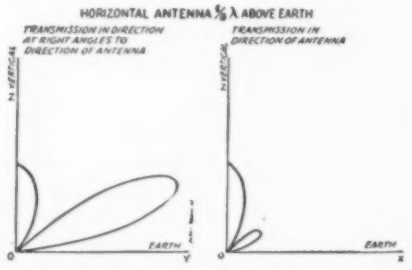


FIG. 20

Figures 9 to 15 inclusive show the theoretical distribution of the radiated power at various angles with the horizontal of single vertical half-wave antennae, without loading and over a perfectly conducting earth. In each case L is the antenna length and d is the distance from its lower end to the earth. The grounded antenna radiates most strongly along the horizontal and the power falls off rather rapidly as the angle above the ground is increased. Thus for an angle of approximately 26 degrees above the horizontal, as shown in Fig. 9, the power has fallen to one-half of its value at the horizontal. Such a characteristic would be useful for medium and long distance communication, but would be valueless for short distance work. The grounded antenna is one-quarter wavelength long, as contrasted with the one-half wavelength of wire for the ungrounded antennae. The grounded antenna would be relatively simple in construction, but difficulty is encountered in obtaining an adequate grounding connection. For short wavelength work, even if buried plates which are bonded together are placed just below the transmitting equipment, it is practically impossible to attain a low resistance connection. The

curve shown was obtained assuming a perfect conducting earth.

Inasmuch as the ungrounded antenna does not require a grounding structure, and since, when it is raised some little distance above the ground the earth losses become quite small, this type has become almost universal for short-wave work. When such an antenna is erected over a perfect earth, the radiation characteristic has the same distribution with respect to vertical angle as has the grounded antenna, when the lower end of the vertical wire is placed at a very small distance above ground, this small distance preventing the conductive flow of current

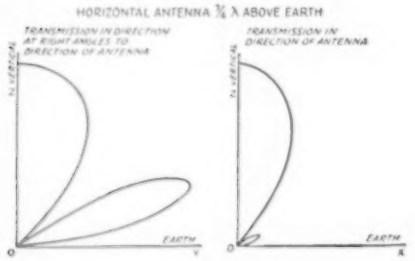

HORIZONTAL ANTENNA ¾ λ ABOVE EARTH
TRANSMISSION IN DIRECTION AT RIGHT ANGLES TO DIRECTION OF ANTENNA
TRANSMISSION IN DIRECTION OF ANTENNA
EARTH
EARTH

FIG. 21

to earth. The characteristic is given in Figure 10, the small diagram at the right of the figure giving the geometry of the system. In both of the preceding cases there is but one leaf to the curve, that is, there is a single maximum and a single minimum; the former occurring for zero elevation, the latter for 90 degrees elevation.

When the lower end of the antenna wire

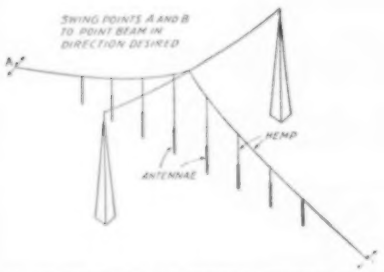


FIG. 22. DIRECTIVE ANTENNA GROUP OF TYPE USED AT 1XV

In the 1XV antenna but 4 vertical antennas were used, being excited as shown in the next two figures.

is raised a distance of ¼-wavelength from the ground, the characteristic takes the form shown in Figure 11. The main leaf of the curve is narrower than before, though the absolute maximum value still occurs at zero elevation. The curve now has two maxima and minima, the second maximum occurring at an agle of 61 degrees from the horizontal, and the second

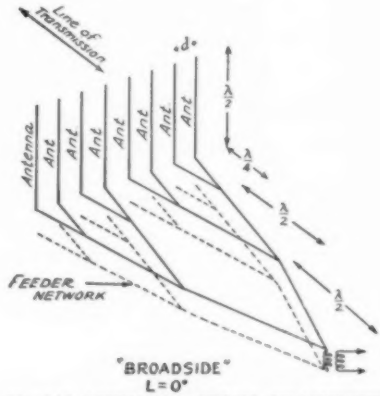


FIG. 23. AN ANTENNA GROUP TRANSMITTING PRINCIPALLY "BROADSIDE", BUT IN BOTH DIRECTIONS AS SHOWN IN FIGS. FOLLOWING. A SUITABLE FEEDER SYSTEM AND ITS NECESSARY LENGTHS APPEAR IN THE FOREGROUND

minimum at 42 degrees from the horizontal. The appearance of the small loop pointing high into the air is readily perceived in the figure.

Upon raising the antenna to a distance of ½-wavelength, the small loop of Figure 8 is increased in size and rotated slightly toward the horizontal, as shown in Figure 12. This loop continues to increase in size and rotate toward the horizontal as the distance of the antenna above ground is increased, while at the same time the main leaf of the curve becomes correspondingly narrower and narrower as may be readily seen from Figure 13 and 14, until the antenna has been raised to a height equal to its own length, i.e., one-half wavelength.

Upon carrying the antenna still further above ground it is found that a third loop appears and gradually increases in size, meanwhile rotating to the right (as does the second loop). The small third loop is just discernable in Figure 15.

CHECK TESTS AT 1XV

Since it was desirable to obtain experimental confirmation of the theoretical conclusions, the calculations were not carried beyond the dimensions which could be realized for the normal wavelength (39 meters) of the Round Hills experimental station, 1XV. The arrangement pictured in Figure 14 was in regular use at that station for some time, and is very interesting because of the double maximum.

The higher angle radiation undoubtedly accounts in part for the very strong signals which the station has been able to produce at distances of from 100 to 300 miles in daytime, while the narrow leaf of low angle radiation may account for the performance of the station in covering several thousand miles with very great consistency at night.

To obtain an operating check on the performance of the system, the antenna system was lowered from the position shown in Figure 14 to that shown in Figure 11, since for the latter position there is for all practical purposes but a single leaf to the radiation curve. This latter characteristic radiated more strongly at angles of 10 to 20 degrees above the horizontal, which resulted in better transmission from the station over distances of the order of several hundred miles at night than could

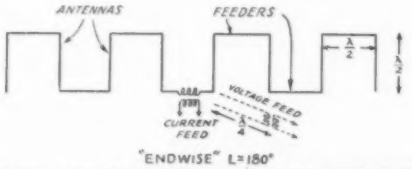


FIG. 24. AN "ENDWISE" GROUP IN WHICH THE H PARTS ACT AS FEEDERS CONNECTING THE V PARTS

The V parts are the antennae proper. Voltage or current feed may be used.

be obtained with the original system. The high angle loop of the original antenna characteristic was practically eliminated, which resulted in much poorer transmission over short distances.

HORIZONTAL ANTENNAS

The horizontal antenna is probably more commonly employed by the amateur station than the vertical antenna and is therefore of considerable practical importance. In the case of the horizontal antenna the resulting characteristic is not symmetrical, as in the case of the vertical antenna, so that in visualizing the results it is necessary to take cuts through the surface of radiation along principal planes, as, for example, planes vertical to the earth and passing through the center of the antenna either in the direction of the wire or at right angles to it.

To avoid duplication of work and to simplify the drawing of curves only one half of the cross section of each cut through the surface is shown in the accompanying figures. Referring to Figure 16, the point O is taken as the origin, this point being located on the surface of the earth, directly below the center point of the antenna. The antenna is shown lying in the XOZ plane, and therefore the plane YOZ is at right angles to the antenna wire.

The curves on the right half of Figures 17 to 21 inclusive show the distribution of the radiated energy in the XOZ plane for various antenna heights. The distance from the point O to any point on the curve, such as A, is proportional to the power radiated

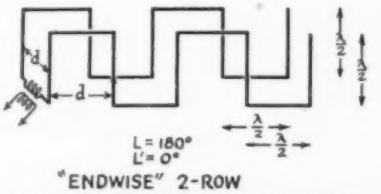


FIG. 25. ENDWISE DOUBLE-ROW GROUP, FOR SHARPENING THE BEAM ABOVE THAT OF FIG. 24

Current feed is shown, although voltage feed is equally applicable, feeder then being connected at the bottom of any V wire.

in the direction OA. In the plane X'OZ the curve is of exactly the same nature as the one shown and because of this symmetry there is no need of drawing complete curves. The curves in the left half of the figures show the power distribution in the YOZ plane, or at right angles to the antenna wire. Duplication is again avoided by not showing the duplicate curve for the radiation in the Y'OZ plane.

These curves were obtained by assuming a perfectly conducting earth, the antenna consisting of a single wire, one half-wavelength long and operated without any loading.

When the antenna is placed ¼-wavelength above the ground a relative power of 100 percent is obtained in the vertical direction, 60 percent at an angle of 29 degrees above the horizontal and very little power for the lower angles, as shown by the curves Figure 17. For the same angle above the horizontal the radiated power *is not the same in the direction of the antenna, as compared with that radiated at right angles to the antenna*, it being greater in the direction at right angles to the wire.

In contrast to the large radiation along the horizontal, obtained with the vertical wire, it is noted that no position of the horizontal antenna results in radiation in the horizontal direction. Considered from the viewpoint of a refraction theory of transmission for short waves, this would indicate that the horizontal antenna could not compare with the vertical for effectiveness for transmission over long distances by "low angle" radiation. In general, this conclusion is sustained by results obtained at Round Hills, 1XV and Auburndale, 1BYX.

The horizontal antenna radiating most effectively at high angles, would by the same theory be very effective over short distances, which was also experimentally substantiated by the stations above.

From Figure 18 and 19 it is seen that as the antenna is raised to heights between ¼

FIG. 26—BROADSIDE GROUP FOR SECURING TRANSMISSION LIKE THAT OF FIG. 23 BUT EITHER UNILATERAL OR BILATERAL

A feed system like that of Fig. 23 is needed. The uni-lateral effect takes place if the rows are ¼ wavelength apart, and properly excited. The bilateral effect takes place when the rows are ½ wavelength apart.

and ½ wavelengths, the intensity in the vertical direction falls off slowly at first and then more rapidly, becoming zero for a height of ½-wavelength. The maximum radiation of 100 percent is obtained for all these positions, but the angle at which this radiation takes place progresses from the vertical toward the horizontal, taking the directions of 0, 48.2, and 60 degrees as shown, for transmission at right angles to the antenna. For transmission in the line of the antenna the maximum radiation falls off and at the same time the angle in which the radiation is confined is reduced, resulting in a small sheaf of radiation confined to an angle of about 50 degrees when the height reaches ½-wavelength. For this condition (curve 19) it is apparent that the system would operate to give much better transmission at right angles to the antenna, both as regards strength of signals and distance as compared with transmission in the line of the antenna. This conclusion was sustantiated by results obtained at 1BYX, Auburndale, Massachusetts, where a horizontal wire running North and South was employed. Remarkably reliable communication was maintained with points in the vicinity of Chicago and Milwaukee (West of 1BYX) but only intermittent communication with points along the Atlantic seaboard (North-South line) was possible. Tests with other antenna systems seem to show that the discrimination in direction in this particular case was due entirely to the directional properties of the horizontal wire.

The curves given cover most of the horizontal antenna systems employed by amateurs, and serve to explain in a large measure many of the peculiarities of transmission which so puzzle amateur operators. If the existing conditions were such as to permit the erection of the most desirable antenna system the vertical type would probably be chosen for general communication purposes.

Considerable effort has been devoted to theoretical studies of directional transmitting antenna systems to find one which is readily realizable in practice and yet one which will yield a sharply directional characteristic. The basic principle generally employed in involving a directional transmitter is that of placing a number of antennae and operating them so as to obtain an addition of their separate effects in certain favored directions, while obtaining an annulment of their effects in other directions. One of the simplest systems used consists merely of a number of vertical wires hung in a line and operated in a manner such that the currents in each wire are either

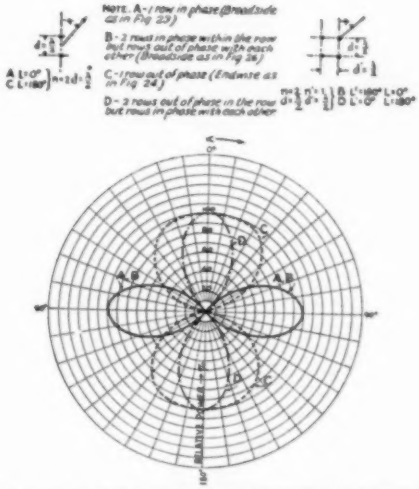

NOTE. A-1 row in phase (broadside as in Fig 23)
B-2 rows in phase within the row but rows out of phase with each other (broadside as in Fig 24)
C-1 row out of phase (Endwise as in Fig 24)
D-2 rows out of phase in the row but rows in phase with each other
A L=0° C L=180°
B L=180° L=0°
D L=0° L=180°
0°
A, B
C
D
BROADSIDE ARRAY

FIG. 27. IN THIS AND THE FOLLOWING FIGURES THE DIAGRAMS AT THE TOP SHOW THE LOCATION OF ANTENNAS, THE VARIOUS SCHEMES ALL BEING VARIATIONS OF THE PLANS SHOWN IN FIGS. 23, 24, 25 AND 26

The curves A, B, C, D show relative power in different directions, the curve to be understood as lying in the correct position with respect to the antenna-scheme shown in the same figure and the meaning of the lettering being as follows: (A), 1 row of antennae worked in phase after the manner of Fig. 23 and therefore transmitting broadside; (B), 2 rows of antennas worked in phase within the row by the same feed system as for (A), but with each antenna of the row supplying the corresponding antenna in the other row, the two rows being out of phase with each other (broadside); (C), 1 row of antennae worked out of phase after the manner of Fig. 24 and therefore transmitting endwise; (D), 2 rows of antennae arranged after the manner of Fig. 25, which is out of phase in the row but with the two rows in phase with each other and therefore transmitting endwise.

in phase or *out* of phase with the currents in the adjacent wires. The operation of the antenna with the currents either *in* or *out* of phase results in two distinct antenna systems, having entirely different characteristics.

ANTENNA GROUPS

If we operate an antenna consisting of a number of vertical wires hung in a line with all the currents *in* phase we obtain an antenna which is directional at right angles to the line of the antenna. This is termed a "broad-side" system since the main beam

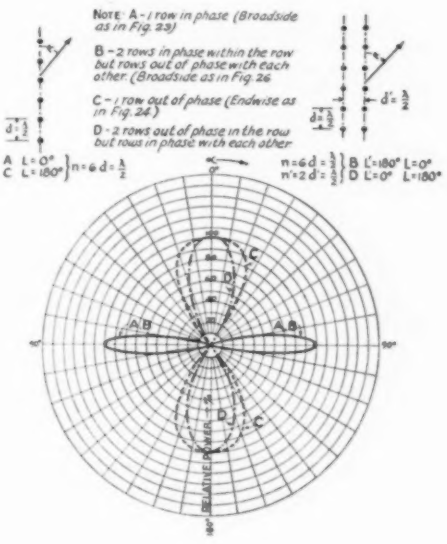

NOTE: A - 1 row in phase (Broadside as in Fig. 23)
B - 2 rows in phase within the row but rows out of phase with each other. (Broadside as in Fig. 26
C - 1 row out of phase (Endwise as in Fig. 24.)
D - 2 rows out of phase in the row but rows in phase with each other
A L=0° C L=180° n=6 d=λ/2
n=6 d=3/4λ n'=2 d'=3/2λ B L'=180° L=0° D L'=0° L=180°
RELATIVE POWER

FIG. 28

is broadside to the line of the array. If the currents in each wire are *out* of phase with those in the preceding wire the system is termed an "endwise" system, since the main beam is in the line of the antenna array.

Before considering the relative advantages of the various possible arrangements it would be well to consider the means for exciting the antenna under the two conditions imposed above. In Figure 22 is shown a possible method of hanging a number of vertical wires by utilizing two towers or masts. The system sketched consists of eight vertical wires, each a half wavelength long and separated by a half wavelength, the height above ground being determined by consideration of the vertical plane characteristics mentioned above (Figures 9 to 15). If we desire to operate this system with all the currents in phase for broadside transmission we may employ the arrangement shown in Figure 23, wherein the antenna is fed by two-wire transmission lines whose length, as

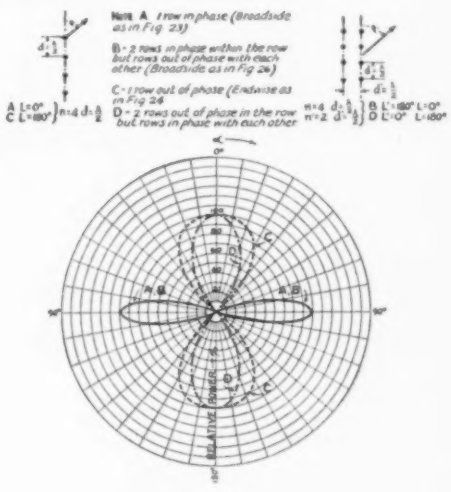

NOTE: A - 1 row in phase (Broadside as in Fig. 23)
B - 2 rows in phase within the row but rows out of phase with each other (Broadside as in Fig. 26)
C - 1 row out of phase (Endwise as in Fig. 24
D - 2 rows out of phase in the row but rows in phase with each other
A L=0° C L=180° n=4 d=λ/2
n=4 d=5/4λ n'=2 d'=3/2λ B L'=180° L=0° D L'=0° L=180°
RELATIVE POWER

FIG. 29

measured from the transmitter to each vertical wire, must be the same for all wires and equal to an odd quarter-multiple wave-

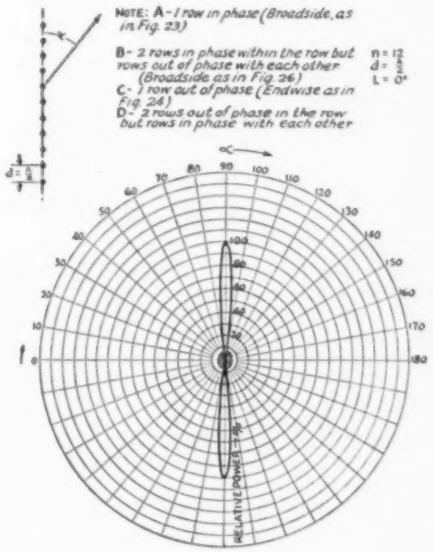

NOTE: A - 1 row in phase (Broadside, as in Fig. 23)
B - 2 rows in phase within the row but rows out of phase with each other. (Broadside as in Fig. 26)
C - 1 row out of phase (Endwise as in Fig. 24)
D - 2 rows out of phase in the row but rows in phase with each other
n=12 d=5/8λ L=0°
RELATIVE POWER

FIG. 30

length. In the figure this distance is 5/4 wavelengths long. The dotted lines indicate the second wire which makes up the

two-wire transmission line described above. This system is adjusted in exactly the same manner as the simple single wire antennae previously mentioned. It is readily seen that this arrangement requires a rather

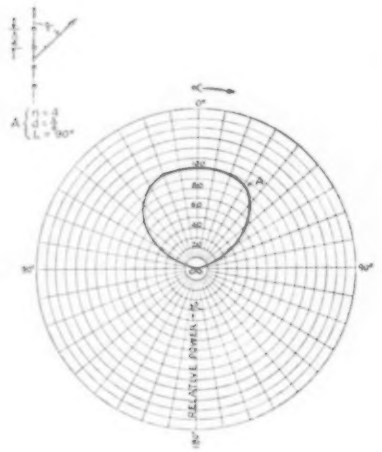


FIG 31

elaborate feeding system, if many antennae are to be excited. As used in British beam stations the feeders are mounted in the center of copper pipes, the pipes acting as the second wire of the feeder system and are mounted on grounded iron stakes.

For the endwise system the connections are much simpler as are indicated in Figure 24. Eight wires are again hung one half wavelength apart and a single continuous piece of wire may be made to serve for a number of antennae and their associated feeders. The system may be fed from a coupling coil placed at a current loop of one of the feeders (at the center of any horizontal part) as indicated, or it may be excited by a voltage feed system consisting of a two wire odd-quarter wavelength transmission line applied to a voltage loop of the system as indicated by the dotted lines (at any corner of the system). This system offers highly desirable characteristics from the view point of installation and operation, but has the disadvantage of a relatively wide beam.

In either system, it is possible to obtain a much sharper beam if two or more rows of antennae are used. Assuming that in each row the antennae are operated in the same manner relative to each other, then various types of distribution may be obtained from the system depending on the manner of operation of the various rows. From a practical operating viewpoint, the addition of a second row does not entail much difficulty, provided that the spacing of the rows is one-half wavelength and that the antennae in one row are operated either in phase, or out of phase, with the antennae in the other row. In the broadside system, the addition of a second row produces no change in the shape of the distribution curve; in the endwise system, the addition of the second row makes the beam about one half as wide. Arrangements for operating two rows of antennae are shown in Figures 25 and 26. The simplicity of the endwise system is apparent; the broadside system, in the lower figure must be excited by means of the transmission line system indicated in Figure 23.

To obtain a sharp beam, it can be shown theoretically to be of little use to place more than one antenna in one-half wave-length of space along the line of the antenna. That is, if a space one wavelength long is avail-

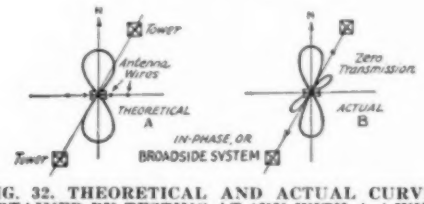


FIG. 32. THEORETICAL AND ACTUAL CURVES OBTAINED BY TESTING AT 1XV WITH A 4-WIRE VERSION OF THE SYSTEM OF FIGS. 22-23-28 A & B

able for the erection on the antenna, the resulting beam will be very little narrower if a dozen antenna wires are used than it would be if only two antennae were used. If a beam of a certain width, measured angularly around the transmitter in a horizontal plane, is desired, it is necessary to have a certain space in which to construct the antenna system; the space required will be greater, the sharper the beam, so that in a practical case, the available space determines for the amateur the sharpness of the beam that may be obtained.

If desired, one of the rows of a two-row antenna system may be placed one-quarter wavelength behind the other, by properly exciting the antenna system "uni-lateral" transmission is obtained. That is, not only will a beam result, but the beam will extend only on one side of the transmitting point, the signals in the opposite direction being very weak. This condition is difficult to attain in practice, but may be sufficiently well established so as to provide antenna directional characteristics which are of material advantage in certain cases. For example, a transmitter located on the seacoast desires to communicate with stations located inland; the characteristic shown in Figure 31 gives practically 100 percent.

transmission over one quadrant, while eliminating radiation over the remaining three quadrants.

The curves shown in Figures 27 to 31 inclusive, represents the theoretical charactertistics, in a horizontal plane, of antennae employing 2 to 12 wires. In the upper left hand corner of the diagrams are shown the arrangements for 2, 4, 6 and 12 wires in a row; in the upper right hand corner are shown the arrangements when a second row is used, the dots representing the wires as they would be seen by looking down on them from above. Curve A in each group gives the directional effect when the antennae are operated in phase (as in Fig. 23); Curve C when the antenna are operated out of phase (as in Fig. 24); Curve B shows the effect of a two-row system, the antennae in each row being in phase, while the rows are out of phase (as in Fig. 25); Curve D is for the two row system, the antennae in each row being operated out of phase, while the rows are operated in phase (as in Fig. 26). It will be seen that the system in which the antennae are operated in phase gives the sharpest or narrowest beam, and that the addition of a second row in these cases does practically nothing toward making the beam sharper. While the single row system in which the antennae are not of phase is not anywhere nearly as good, considering the sharpness of the beam, the addition of a second row materially improves the beam. However even after the addition of the second

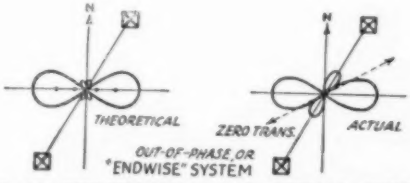


FIG. 33. THEORETICAL AND ACTUAL CURVES FOR 4-WIRE 1XV SYSTEM OF TYPE OF FIGS. 22-24-28 C & D

beam, is not anywhere nearly as sharp as is obtainable with the "broadside", or in phase system.

TESTING 36-METER BEAM SYSTEMS AT 1XV

For Figure 30, in which 12 wires are placed in line at distances of a half wavelength, the resulting beam is quite narrow, the relative power dropping to 50 percent of the maximum for directions differing from the line of the array by only 4 degrees. As an estimate of the space required for such a system, for 40 meters, we find that the line of antennae will be about 720 feet long, which is rather difficult to construct, since each of the antenna wires must be 64 feet high. By making use of the towers at Round Hills, support was arranged for four antenna wires, one-half wavelength apart, for 40-meter transmission.

This four-wire directional antennae has been operated both as a broadside and as an endwise system for several months at 1XV on 38 meters. The theoretical energy distribution of this antenna when used for broadside transmission is shown in Fig. 32a. Measurements made with field strength measuring apparatus upon the actual system as installed showed that the actual energy distribution was that shown in Fig. 32b. This distortion of the field was caused by the steel towers which supported the antenna and were placed as shown in the figure. As has already been mentioned the distance of each tower from the antenna system is approximately one-half of the operating wave and since the currents

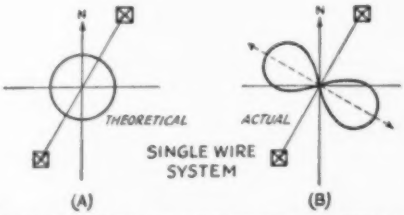


FIG. 34. RESULTS AT 1XV WITH VERTICAL ANTENNA, SHOWING DISTORTION DUE TO STEEL TOWERS

in all the antenna wires are in phase the towers act as a reflecting wire place one-half wavelength from the antenna proper. Thus the steel towers cast a decided "shadow" and cause a "splitting" of the beam.

In the case of four wires operated as an endwise system the theoretical and actual curves were as shown in Fig. 33. In this system the antennae are operated out of phase and the transmission is aided in the line of towers.

It is readily seen that if the total power fed to a given antenna system is kept constant that the directional system will send considerably more power in a given direction than will the non-directional arrangement. At 1XV, signal strength reports received from stations that were in the beam were materially greater when using the four-wire directional system mentioned, than the reports obtained when using the usual single-wire vertical antenna, for the same tube input in the two cases.

Another type of directional system consists of a very long, low, horizontal wire, broken up into half-wavelength sections. Between the half wave sections are placed tuned circuits, which actually amount to

non-radiating half-wavelength sections. In this way the currents in the active half wave sections may be brought practically into phase, so that the effects of the separate antenna sections add up in a direction at right angles to the line of the antenna. The arrangement of the system is indicated

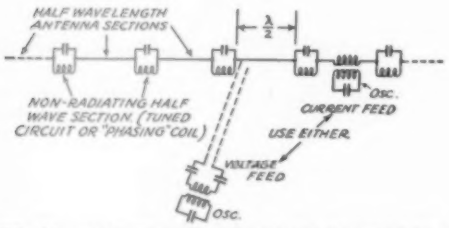


FIG. 35. ANOTHER "BROADSIDE" SYSTEM UTILIZING A LONG HORIZONTAL WIRE IN WHICH THE SECTIONS FEED EACH OTHER THROUGH INTERMEDIATE "PHASING COILS" OR THROUGH CLOSED CIRCUITS TUNED TO THE WORKING WAVE AND ACTING AS PHASE REVERSERS

..The distribution is given in Fig. 36. Current feed may be used for each section in the manner shown in another figure.

in Figure 35. The system may be fed at the center of any one of the antenna sections, by "current" feed, as indicated, or may be fed at any of the junctions between a radiating and non-radiating half wave section as shown by the dotted lines. The non-radiating sections may be made up of a coil and condenser, very nearly tuned to the operating wavelength, or the condenser may be eliminated by making the coil practically self-resonant. In the latter case the coil is generally called a "phasing coil".

The directive curve of the system is shown in Figure 36, when looking down upon the antenna. The angle "A", measur-

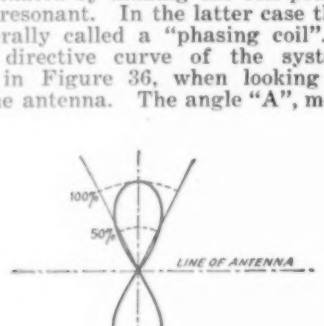


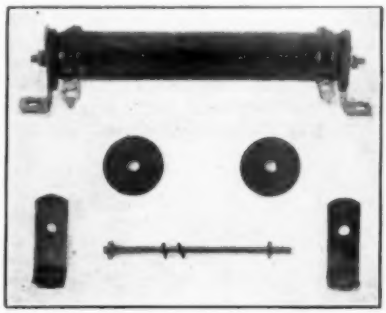
FIG. 36. TRANSMISSION CHARACTERISTICS OF THE SYSTEM OF FIGURE 35

ing the angle between the direction giving 50 per cent of the maximum radiation on one side of the maximum to 50 percent of the maximum on the other side of maximum, depends upon the number of the radiating sections as follows (according to Meissner): 72 degrees for one antenna, 42 degrees for two antennae, 32 degrees for four antennae and 14 degrees for eight antennae. Thus to produce a sharp beam we encounter the same difficulty as in other systems, the dimensions of the systems must be large compared with the wavelength. For a 14-degree beam at 40 meters, the length of the system would be 8 x 20 meters, or approximately 525 feet.

The characteristics of this antenna system in a vertical plane are similar to those previously given for a single half wavelength radiating section. If the height is made an odd multiple of quarter wavelengths then the energy radiated vertically is a maximum, while if the height is an even number of quarter wavelengths the energy radiated vertically is zero, if the ground is highly conducting.

Resisto Props

IT is strange that although resistors are used so frequently in radio work, the manufacturers of them have been content with supplying them without any particular means for mounting in a secure and permanent fashion. Many have been the contraptions that have been hastily contrived



with the view of holding such units and many more times have they been "mounted" by their leads or terminals.

It is good to know that there are now available some honest-to-goodness mounts for the commonly used tubular shaped units. Two metal angles act as the "feet" of the mounting and a rod, threaded at both ends, is passed through the center of the resistor and the holes in the mounting brackets. Fibre washers act as cushions between the ends of the unit and the metal pieces. Nuts allow the entire assembly to be tightened up to a desirabe condition and lock washers prevent them from working loose.

The resistor shown is also a product of the same manufacturer.

Resisto Props may be obtained in two sizes, so as to fit two-inch and four-inch resistance units. They are a product of the Daven Radio Company of Newark, N. J.

—*H. P. W.*

Double-Detection Receivers With Band-Pass and Screen-Grid Amplifiers

(Continued from Page 16)

other hand if one wishes to have a beat note there must be a long-wave heterodyne to beat with the second detector or else one must make the second detector itself oscillate. A not particularly good alternative for this is to make the intermediate frequency tube oscillate as was done in the double-detection receivers (with standard tube, not with 222) described in *QST* for January, 1927 (p. 40), June (p. 9) and February 1928, (p. 41) and also in the receiver of Fig. 6; though in the last case it was done for comparative purposes only. As expected the autodyne 2nd detector was materially the better device.

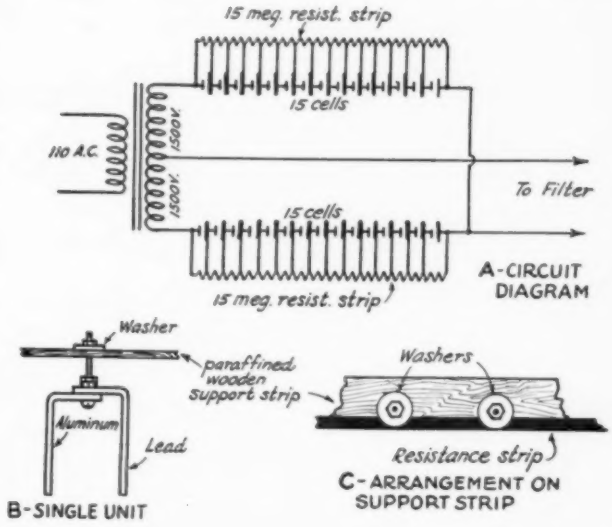
Mr. Ross Hull has suggested that the receivers just referred to may be both improved and simplified by replacing the i.f. tubes with a single UX-222, so that the final system will consist of an autodyne first detector, a 222 i.f. tube, an autodyn 2nd detector and possibly one a.f. tube. This is again the system c previously referred to, with the change that the 2nd detector is oscillating. As was said before, such systems with standard tubes (less band-pass) have been described but in these cases the i.f. was more or less regenerative (see Fig. 6) and in some cases oscillating, thereby causing some interference with the autodyne first detector, not only as to twitterings but also in the way of a tendency to make the first detector howl when the i.f. regeneration was changed. The exception was a 5-meter receiver shown in Fig. 8 and in this case the intermediate frequency was not a favorable one, being about 665 Kc. The combination seemed promising however and was easy to handle as well as being quieter than the ordinary i.f. but not as quiet as the receivers equipped with band-passes.

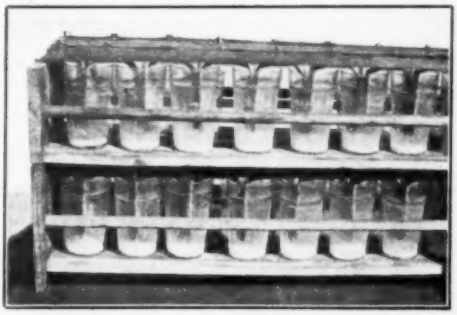
The Rusco transformers may be obtained from the Columbia Metal Products Co., 57 E. Ohio St., Chicago, Ill.

More will be said in *QST* about this type of receiver.

An Amendment to the Cure

IN the article "A Simple Cure for an Old Ailment", by A. J. Haynes (December, p. 44) there should have appeared a circuit drawing and a photograph. The post-office together with the mysteries of putting the magazine helped to keep the two illustrations out. At the moment when this is written the photo has appeared, and the diagram is on hand also.





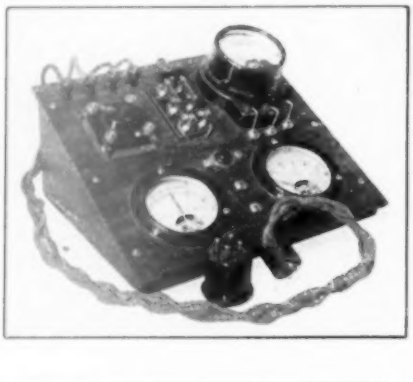
HERE IS THE ARRANGEMENT OF THE RECTIFIER

They therefore appear herewith with our apologies that they could not have appeared in *QST* last month.

Two Inexpensive Test Sets

By Frank Palmer*

PERHAPS I should qualify the title of this article somewhat, and call it a comparatively inexpensive test set, in that it may be built for a great deal less money than is asked for the commercial articles of this type, which according to my experience are in many ways less convenient, and do not offer such varied uses as mine.



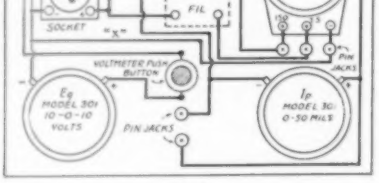


FIG 1a

FIG. 1. THE "BENCH BOARD" TYPE OF TEST PANEL FOR TUBES UP TO AND INCLUDING 201-A.

When operating with the test cord plugged into a set, meter reads plate voltage, with the switch down it reads filament voltage. Plate current can be read at any time on the milliammeter and grid bias can be read on the zero-center voltmeter by pushing the button at the center of the panel. When testing a tube apart from a set the batteries are connected to the 4 binding posts, the tube is plugged into the socket and the readings made as before. Any C battery that is desired may be connected across the B minus and A minus posts, otherwise the grid is open until the voltmeter button is pushed and then drops to "zero grid," in other words is returned to the negative filament.

For other work the meters are independently available by use of the pin jacks and the two left-hand binding posts. The only permanent inter-connection is between the negative terminals of the two voltmeters. A single-pole switch cut in at "X" would interrupt this if there seems to be any advantage in complete independence. The two-pole switch must of course be open.

Photos by Author.

It has long been the custom to make radio sets more impressive by "dolling" them up with filament voltmeters and ammeters. These pleased the hick from the high grass immensely, but as far as telling anything vital as to the operation of the set, the ammeter was entirely useless and the voltmeter very nearly so. This latter instrument was anchored to the receiver panel so it could not be used for any of the countless purposes it might otherwise be available for.

After my graduation from the hick class, I frequently found myself chasing all over the place to find my filament voltmeter. Having satisfied that curiosity, I would most likely repeat the operation for a plate voltmeter; about that time I'd get a hunch my grid bias was not right, and a search for the milliammeter was started, which resulted in disconnecting everything in sight so I could ascertain said grid bias. After keeping this up for some time I suddenly saw a light, and in December, 1926, I nailed all the blamed meters to a board as shown in the accompanying photograph of Fig. 1.

In Fig. 1, I have used the less expensive Weston meters. The Model 489 double-range low-resistance voltmeter is used coupled up with a double-pole double-throw switch as indicated in Fig. 1A and 1B. The addition of pin jacks as shown makes these meters available for other purposes though the test leads are of a substantial size and insulated with rubber hose as shown in Fig. 2A.

The flush type 301 meter lends itself nicely to the arrangement as shown. The push button throws the grid bias meter in or out of the circuit at will.

To make it convenient to test tubes in connection with the sets to which they belong—especially to check the continuity of the circuits—there has been made up a test plug with a flexible cord as shown in Fig. 1A. This cord can be plugged into the socket of the set, the tube then being transferred to the socket of the test board. By using a UX socket on the board and a UV-199 plug on the cord it is possible with the ordinary adapters to handle all the usual varieties of tube bases and sockets. The test plug is made by cleaning out the base of a 199 peanut tube, unsoldering its leads and replacing them with eighteen-or twenty-inch lengths of ordinary No. 16 cotton covered lamp cord. These cords are then placed parallel to the sides of the base and melted

(Concluded on Page 40)

*Atlantic, Mass.

Another "Code-Learning" Set

By Harold P. Westman, Assistant Technical Editor

MANY sets have been described for those who are desirous of learning the code by listening to long-wave transmissions. Some of these have used the very minimum of equipment and left the problem of getting the set to work to the picking of a suitable tube, the characteristics of which would fit in with the other constants of the set. In many cases the inexperienced man has been unable to get satisfactory operation from them and in an effort to get reliable action has gone to the other extreme and put in everything that could be thought of.

The set to be described falls in neither of these classes. It gives an honest-to-goodness control of regeneration as well as wavelength. At the same time, the amount of equipment is small and the circuit of the simplest form.

The circuit appears in Figure 1. As will be noted, two inductance coils are needed. One is shunted by the variable condenser and is connected between the grid and filament of the detector tube and the other acts as a tickler coil being in the plate circuit of the detector and coupled to the first coil. The antenna and ground are connected across the first coil, this arrangement being commonly referred to as a "single-circuit tuner". It may be said in its favor, that it gives the loudest signals of all methods of antenna coupling. As drawbacks, we find that it tunes broadly and when in the oscillating condition radiates, acting as a miniature transmitter. However, for code practice one does not of necessity listen to any given station but may pick out the loudest one and under these conditions the broad tuning will not be so damaging as it would be were it required that one listen to some pre-determined signal. As far as radiating is concerned, the average 100- or 150-foot receiving antenna is not very effective in radiating at wavelengths above eight or nine thousand meters. One should also consider that there are very few receivers operating in any average location which might be interferred with.

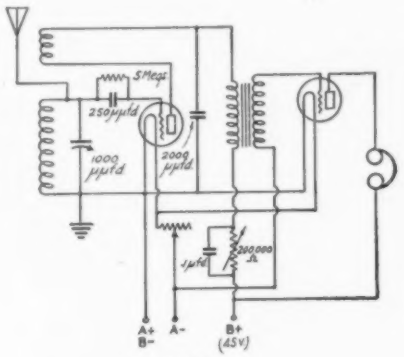
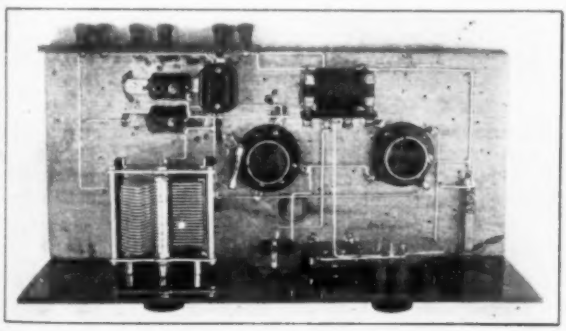


FIG. 1



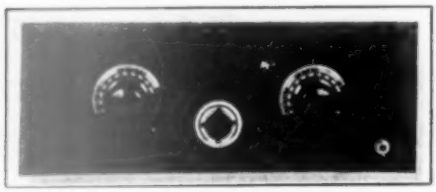
SHOWING THE SET WIRED

Regeneration is controlled by means of a variable high resistance in the B-battery lead to the plate of the detector. The plate voltage is equal to the voltage drop across this resistor subtracted from the B-battery voltage. As the resistance is varied, so is the plate voltage varied which in turn affects the amount of regeneration occurring in the circuit. It will be found that this method offers a very smooth control which causes little detuning.

The inductances used are duo-lateral coils. This particular set was built to employ coils mounted on plugs although there is no reason in the world why one cannot use unmounted ones and a couple of pair of Fahnestock clips to take the leads.

Why folks should be more inclined to guess, rather than calculate, in which direction the tickler coil should be connected, in order that the feedback will be in the proper phase for causing oscillations, is a profound mystery. Perhaps laziness is the answer, for it certainly can't be ignorance! No, not with such a simple and fundamental example in front of one as the Hartley cir-

cuit. If the grid and tickler coils are wound in the same direction and are placed end to end, it is only necessary to remember that the grid and plate connections come from the extreme ends of the coils or from the



THE PANEL VIEW OF THE SET

two inner ends. Don't run the one to an inner end and the other to an outer end for that won't function properly, at least not unless the coils are *not* wound in the same direction. In this particular case with duolateral coils, one might become a bit hazy as to the direction of winding. A simple plan is to mount the two plugs parallel to each other with the jacks (holes) on the same side and then mentally slide one of the mounting plugs alongside of the other so that all the plugs and jacks are in a straight

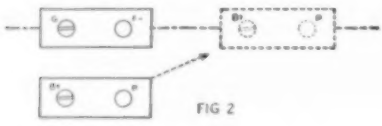


FIG 2

line. When doing this, don't turn either plug around. When they are lined up, consider the two terminals of each plug as the terminals of the winding with the windings in the same direction. The diagram may help you to understand matters more easily so see Figure 2.

The mounts for the coils are an extra pair of the plugs which usually adorn them. Two pair of metal angles solve the problem of nailing them down to the baseboard. Any sort of a variable condenser that has a capacity of between 500-μμfd. and 1000-μμfd. (.0005 to .001 μfd.) will do the trick UX-type sockets would allow either dry-cell or storage-battery tubes to be used although in this particular case a pair of 201-A's is used and the sockets even though they are not mates were on hand and do all that is necessary as far as operation of the set is concerned An audio transformer out of an old B. C. set will do nicely or else one of the many that can be purchased for less than a dollar. The same idea applies to the other equipment used. The requirements are not very exacting and parts from an old set will probably be quite as satisfactory as would parts purchased especially for the occasion.

The following table will give the wavelength ranges of various coil combinations. They assume a tuning condenser of 1,000 μμfds.

Wavelength Range	Grid Coil	Tickler Coil
2,550 — 4,250	300	150
4,200 — 6,300	400	150
6,240 — 14,500	750	400
13,600 — 21,000	1250	400

It is to be noted that one may cover the range of from 6,240 to 21,000 meters with but three coils, the same size tickler being suitable for both grid coils. This combination will give one all the code instruction that could be desired. The two smallest coils will allow NAA, Arlington, Va., working on 2,655 meters to be picked up directly for time signals, news and weather reports at noon and ten p.m., E.S.T. This, in the early days, was considered an excellent chance of doing some real DX but at the present is not considered as being so "hot". However, curiosity usually causes one to take a listen and so the proper sizes of coils are shown.

Midwest Division Convention

Ames, Iowa, April 13th-14th

THE Annual Radio Short Course will again be given by Mr. D. C. Faber, Director, Engineering Extension Department, Iowa State College, Ames, Iowa, on the dates mentioned above. This convention has become known as one of the best in the country where one may obtain the best there is in technical radio. This does not mean, however, that the brass-pounder is forgotten because the convention will be under the general supervision of Director Quinby and A. W. Kruse, Section Communications Manager.

Harold P. Westman, Assistant Technical Editor, *QST*, will be with us and will represent A.R.R.L. Headquarters. Fred Schnell, former A.R.R.L. Traffic Manager, is expected to be present and Professor J. M. McNeely, besides several other good speakers, who will make the meetings interesting.

All events are to take place at the college.

Mr. D. C. Faber will be glad to hear from those who contemplate being present.

All About the Tube-Base Receiver

By P. H. Quinby*

JUDGING from the number of requests I have been getting for additional information on the construction of the "tube base" receiver, I am beginning to think would be short lived; that I could evenually wade out and get square with the mailman again.

But just as I was hoping the thing had been forgotten about, Mr. Handy blossoms forth with a revised Handbook telling the gentle reader just enough to pique his curiosity and give him an appetite for more. And if my mail is a criterion, the market for those Handbooks is certainly brisk. Individual replies were impossible. I had to make up a drawing with everything on it I could think of except the color of the panel, and get a flock of prints made.

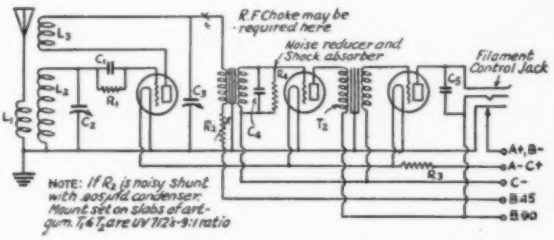
As previously stated, simplicity is paramount. The circuit is not new. There are a few minor changes worthy of note. After making numerous comparisons of "capacitance" and "resistance" control of regeneration, I find that, for ordinary detector plate voltages, the capacitance method gives the greater signal strength, but resistance method has the lesser effect on tuning of grid circuit. It is easy to understand why the capacitance method effects grid tuning. In the resistance method, the conventional fixed condenser used to replace C3 in the diagram is much too large. Its reactance at high frequencies is so low that oscillation does not die out until the resistance R2 drops the plate voltage far below the point of maximum efficiency for detection. This accounts for the reduction of signal strength when using this method.

In order to offset this evil the capacity of C3 must be reduced until its increased reactance requires a plate voltage sufficiently high to give good detection before forcing the tube into oscillation. This value will vary with tube, circuit constants and general arrangement of parts. The simple way is to make R2 and C3 both variable, then adjust them in combination until maximum signal strength is attained. With this setting of C3, we can then control regeneration with R2 without a sacrifice of signal strength. This combination then gives us the benefits of both methods.

With a two-stage amplifier on a pair of head phones we usually find a multitude of circuit noises. Grounding the audio transformer frames will usually quiet down the amplifier itself (test by removing antenna, ground and detector tube). If it is still noisy look at your batteries and terminals. To shut off the noises in the detector circuit is not so easy. You *must* have a good, quiet grid-leak. The tube itself must be good. Even then some noise comes thru. To reduce it, C4 and R4 (see diagram) are placed cross the secondary of the first transformer. This cuts the signals down somewhat but seems to cut the noise more; makes the wearing of a headset quite comfortable, and still leaves enough signal to be heard all over the room.

For those wishing ultra-simplicity, the rheostat R3 can be replaced with an Amperite to fit your tubes, and the jack can be made filament control, taking two controls off the panel.

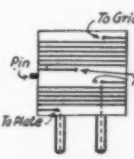
It is a big advantage to cut the tuning condenser C2 down until one amateur band covers nearly all the dial. This may be done by removing plates from the midget condenser used. It is also advisable to set C2



REFERENCE TABLE	
C1	.0001 mfd. Mica Fixed Condenser
C2	.00015 mfd. Midget Variable Cond. 1 plate
C3	do.
C4	.0005 mfd. Mica Fixed Condenser
C5	do.
R1	10 Megohm Grid leak (Noiseless)
R2	0-50,000 Ohm Bradleyohm
R3	Rheostat or Amperite
R4	1/10 Megohm Gridleak
L1	2 turns bell wire around coil socket base
L2	Grid coil on plug in tube base
L3	Tickler " " " " "

Wave Band	L2 Turns	L2 Wire Gage	L3 Turns	L3 Wire Gage
80	37	28	25	30
40	16	22	20	30
20	7	22	10	30
10	3	20	5	30
5	1	20	3	30

SHORT WAVE RECEIVER USING TUBE BASE COILS AND MIDGET CONDENSERS
BY
P. H. Quinby - 9DXY - St. Louis, Mo.



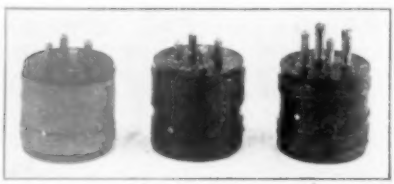
TUBE BASE COIL

NOTE: Remove old tube & leads from base. Drill small holes for leads. Wind both coils same direction. Run ends of coils thru prongs & solder.

ADVANTAGES: High L:C Ratio. No heavy end plates in condensers. High amplification with low noise level. Combined capacity and resistance control of regeneration. Good form factor in inductance. Economical efficient plug in system. Better signal spread over dial. Simplicity - Compactness.

*9DXY, Director Midwest Division, A.R.R.L., 817 Lauderman Building, St. Louis, Mo.

and C3 back from the panel to eliminate hand capacity effects on waves below 30 meters. Constructional data for the coils is shown on the chart for various amateur



THE SCOTTISH RECEIVER COILS

bands. These will vary slightly with the general arrangement of parts and wiring, but final adjustment may be made by adding or deducting a turn or so until the band is centrally located on the dial, and smooth regeneration is secured over the whole band. If dead spots occur it may be necessary to detune the antenna or loosen coupling to grid coil. If the coils are wound on UX tube bases and the antenna coil is wound around the socket base, coupling may be loosened by pulling the tube-base coil up away from the socket. Nearly ⅜" adjustment can be had in this way.

A receiver of this type is well within the means of everyone, and if properly built is without a peer. Its smooth control of regeneration makes it well adapted for short-wave phone and broadcast work, and the boon of the brass pounder.

BOOK REVIEWS

By R. S. Kruse, Technical Editor

EMILE BERLINER, Maker of the Microphone, by Frederick William Wile. Introduction by Herbert Hoover, published by Bobbs Merrill, Indianapolis, 353 pages, 19 photo illustrations, price $4.

Mostly we radio folks are too absorbed in our own affairs, too little informed of other things, even those next door to us in the electrical arts. It is well, then, to depart from the trail and let Mr. Wile lead us into the paths trodden by Emile Berliner who worked in the allied field of telephony, but who did not stop there but touched upon many things indeed. His story is not yet done though it began long before radio and was intimately knit with the beginnings of the telephone. However so much has been touched by him in these years that there is much to tell—and the author has told it well.

Wireless Direction Finding and Directional Reception, by R. Keen; 2nd Edition, 490 pages, 329 Figs., published by Iliff & Sons Ltd., Dorset House, Tudor St., London, E.C.4, England, Price 21 s.

The American reader is at once struck by the rather small share of space assigned in this book to those methods of directional reception which employ special collectors of antenna form, such as the Beverage antenna. Correspondingly a very large share of space is given to reception with loops, or as the English term has it "frames", especially the large crossed coils of the Bellini-Tosi system. This is quite probably a survival from the first edition which was named "Direction & Position Finding by Wireless"—which still remains the main subject of the book. The limitation must not in any manner be thought of as a defect for even in 490 pages one cannot cover all the phases of directive reception, including measurements of field strength and direction. It was wise therefore to follow the plan of "doing" the radio compass thoroughly, so thoroughly that the average reader will be quite surprised at the multiplicity of the things he had not considered at all.

Practical Radio Telegraphy, by Arthur R. Nilson and J. L. Hornung. 380 pages, 223 illustrations, Published by McGraw-Hill Brook Co. Inc., New York. Price $3.00.

The authors of this book are both of the West Side Y.M.C.A. Radio Institute of New York City and the book is intended as a text for prospective radio operators. In view of the utter lack of a modern text for such work the book is certain of a good reception.

There are surprisingly few of the usual accidents and oversights that one expects in a first edition. Even the large portions quoted from operating manuals for commercial apparatus have been freed from the horrible grammar that is ordinarily found in such works.

To the Technical Information Service the book will be a relief—there is now an answer to the standard question, "Where can I find out something about commercial radio operating?"

Elimination of Inductive Interference in Radio Reception by J. O. Smith, Published by Radio Corporation of America, 22 pages, mimeographed.

It is most unfortunate that this booklet has marred an excellent purpose by claiming such a large excess of glory for its publishers. To deprecate the idiotic American tendency to cure everything by a hasty law, ignorantly conceived and stupidly passed, is a very good thing. But why base the argument on a suggestion that the writer's firm has been in the fore-front of the weary detail search for the causes of "man-made" interference when it is possible to cite a lonely 500 cases

Except for this thing of getting the cart before the horse, the book is good. It exposes the dreary myth of the "leaky transformer", just as N.E.L.A. and R.M.A. have been doing these past years, quote very extensively from Stephen B. Davis of the Dept. of Commerce concerning the advisability of local radio laws and then differs with him quite effectively (for which difference this reviewer compliments the author) and winds up by giving some of the left-over credit to the N.E.L.A. Coördination Committee and R.M.A. After all it turns out to be a matter of peculiar perspective—the facts are corrected.

New England Convention

April 20th-21st, Boston, Mass.

ALL aboard for Boston. Hear ye New England Hams: prepare yourselves for the annual New England Division convention to be held at the New Elks Hotel in Boston, Mass., April 20th-21st under the auspices of the Eastern Mass. Amateur Radio Association.

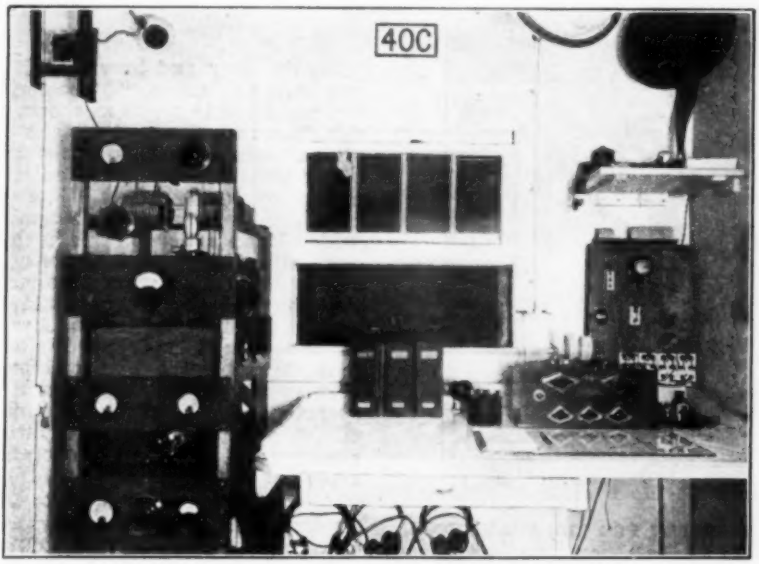
The committee in charge will have one of the best programs ever given for the delectation of the delegates. All are cordially invited to attend. Write the secretary of the association Miss Gladys Hannah, 1KY, 3 Summer Road, Cambridge, Mass. for your reservation.

nu4OC

WHEN a pair of five-watt tubes was first installed at 4OC, this was the only station in Durham, N. C. There being no assistance available locally, recourse was had to the League's Information Service for the solving of the many difficulties that arose during the period of construction and adjustment. Many thanks are herewith tendered for the patience with which the myriad questions were answered by that Service. Later, a friend at the University of North Carolina was kind enough to give a few instructions which helped things along wonderfully and made it possible to obtain a first class license.

The small tubes soon gave way to a single 203-A and a 1500-volt, Esco motor-generator was acquired. In spite of its being thoroughly filtered and giving a smooth output, all reports were choppy, unsteady and everything else that one would not desire. It was finally decided that crystal control was the answer to the question as its performance could not be any worse than that of the oscillator arrangement in use.

A 79-meter crystal and an excellent dust-proof holder were obtained from the Scientific Radio Service of Mt. Rainier, Maryland. A UX-210 was used as the crystal tube and the 203-A was employed as a frequency doubler. After several all-night attempts, current was finally put into the antenna. The circuit adjustments failed to hold properly and finally an additional amplifier was put in. This was a worthwhile advance and made a world of difference in the adjustment of the set. A considerable amount of experience was obtained from this experimenting and the idea that it requires a great deal of testing to get a crystal transmitter in action was brought home strongly.



THE OPERATING TABLE AND TRANSMITTER AT 4OC

The wooden handle on the wall at the right is connected by means of a wooden strip with the switch to control the motor-generator which is located across the room.

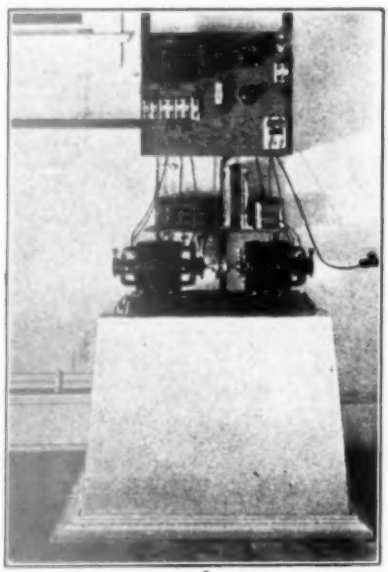
TRANSMITTER

From the photo you can see that the frame is made of wood. Oak was used and dipped in paraffin. This made it look as if it had been varnished, as well as protecting it from damp weather. From top down can be seen the antenna lead-in which is a pyrex bowl. One-quarter inch copper tubing is used for all connections from transmitter to antenna system. The antenna switch has mounted next to it a 500-μμfd. series condenser which at present is not in use.

On the top panel in the frame is the antenna meter and primary tuning condenser. Next can be seen the antenna tuning condenser which shunts the antenna coil, and the amplifier plate coil.

The coils, which are mounted on glass rods, are spaced 4¼ inches and the current in a third harmonic antenna is somewhat over one ampere. (Of course, the highest antenna current is not necessarily the best, but from the flattering reports received here now, this is without question better than anything yet tried at this station.)

On the second panel can be seen the a.c. filament voltmeter. Directly beneath it there is a small knob which is a two-pole



THE POWER SUPPLY FOR THE TRANSMITTER

The concrete base is built from the ground up and is not resting on the floor or touching any part of the room. The switchboard is hung from the ceiling and vibration from the rotating machine can only be transmitted through the wiring. The strip of wood running out of the switchboard just below the four knife switches connects to the switch controlling the motor-generator and is terminated at the wooden handle that appears in the other view.

switch making the reading of both filament voltages possible. Below this panel comes the intermediate stage. In the photo may be seen an oak box. This is used only for looks and covers the copper box which holds the intermediate stage. The controls for the tuning of this stage are at the side facing the operating table. The neutralizing condenser C5 (see circuit diagram) is enclosed in the copper box with the intermediate stage. Directly above this stage on the side are two condensers. The one nearest the reader is C6, neutralizing condenser, and the other one is C7, feeder condenser between intermediate stage and power amplifier.

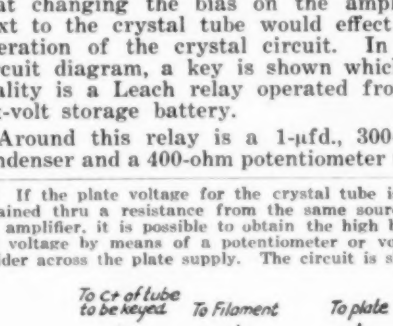
Next comes the third panel from top which holds a 0-2000 d.c. voltmeter and 0-300 milliammeter. In between these two meters can be seen another small knob. This operates a double-pole switch making it possible to read both plate voltages. The milliammeter is used in the 203-A circuit. In the center just below this panel is the feeder condenser, C, between the crystal oscillator and the intermediate stage. On the bottom panel is a milliammeter, tuning condenser, and an r.f. ammeter, which are in the crystal oscillator circuit. This circuit is contained in a copper box directly behind this panel. The C bias batteries for this circuit are also enclosed in the same box with the crystal circuit. Directly below this panel is the equipment for keying.

KEYING

On the floor and lowest shelf there are two units of Burgess "C" batteries. These are connected in series as shown in the circuit diagram. When the key is open it applies a very high bias to the grid of the power amplifier tube, high enough to completely block the tube. When the key is c >sed, the normal bias is applied to the grid.[1] In an article on this in the January, 1927 issue of the Proceedings of the Institute of Radio Engineers, it is recommended that one of the intermediate stages be keyed. In this particular case, however, the power amplifier is keyed as it was found that changing the bias on the amplifier next to the crystal tube would effect the operation of the crystal circuit. In the circuit diagram, a key is shown which in reality is a Leach relay operated from a six-volt storage battery.

Around this relay is a 1-μfd., 300-volt condenser and a 400-ohm potentiometer used

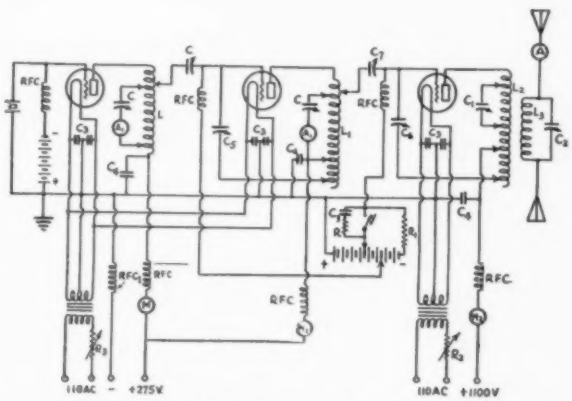
1 If the plate voltage for the crystal tube is not obtained thru a resistance from the same source as the amplifier, it is possible to obtain the high blocking voltage by means of a potentiometer or voltage divider across the plate supply. The circuit is shown



herewith and if R has one half the resistance of R1, the voltage drop across it will be one third of the total across the two. When the key is open, one third of the "plate" voltage is applied to the grid and the rest to the plate. When the key is closed, all the voltage is applied to the plate and none to the grid because the resistor R has been short-circuited. The resistor R1 is then just shunted across the plate supply system and must be capable of dissipating the amount of energy it takes from the supply. In this particular case, R may be 100,000 and R1 200,000 ohms, both capable of dissipating 10 watts.—Assistant Technical Editor.

to prevent key thump due to the relay circuit. The relay is located directly behind the top unit of "C" batteries. It is enclosed in a dust proof box and mounted on rubber to prevent vibration.

From the diagram it will be seen that when the key is open the whole "C" voltage is impressed on the grid of the power amplifier. A complete blocking of the grid is necessary and the amount of bias will vary according to voltage supplied to the grid from the preceding stage. When the key is closed it reduces this bias to the proper working voltage. Changing this bias is a very convenient way to control the output of the power amplifier. The resistance, R3, is very high and as the current flow is practically nil there has been no noticeable difference in the life of the batteries and their expected shelf life. This system seems to be the best one tried here in regard to key thump.[2] While trying the center tap method, the key thump was terrible. Now, however, the b.c.l. set next door, which is about thirty feet from the transmitter, fails to register the slightest trace of key thump. A short-wave set can be tuned one degree off wave and absolutely no key thump is present. Until this system was installed many complaints were made and it looked as if the case were hopeless.



SCHEMATIC DIAGRAM OF THE TRANSMITTER

A—r.f. ammeter, 0-1.5 amperes.
A1— " " 0-2.5 "
M—milliammeter, 0-75 mils.
M1—milliammeter, 0-100 mils.
M2—milliammeter, 0-300 mils.
RFC—85 turns No. 26 d.c.c. on ½ inch form.
RFC1—250 turns on 2.5 inch form
C—250-μμfd. receiving condenser.
C1—500-μμfd. transmitting condenser.
C2—250-μμd. receiving condenser.
C3—By-pass condenser 1-μfd.
C4—2,000-μμfd., 3,000 volt condensers.
C5—200-μμfd. receiving condenser.
C6—150-μμfd transmitting condenser.
C7—230-μμfd. transmitting condenser.
R—400 ohms.
R1—10,000-ohm Ward Leonard resistor.
R2—Allen Bradley Radiostat.
R3—210 Bradleystat.
L—18 turns No. 6 copper wire on 3 inch form.
L1—11 turns No. 6 copper wire on 3 inch form.
L2—7 turns of 5 inch REL inductance.
L3—4 turns of 5 inch REEL inductance.
The plate and filament voltmeters and their switches are not shown.

POWER SUPPLY

The power used on the plates of the tubes is obtained from an Esco motor-generator, which has ball bearings and will deliver 1500 volts. It delivers three different voltages, but only two are used. The black box at the left top of switch board is a voltage regulator and about 1100 volts are used on the 203-A. Another tap from the motor-generator is used which supplies 275 volts to the two UX-210s. The motor is of one-quarter horsepower and is directly coupled to the generator. The machines are mounted on a solid concrete base which is built from the ground up, and does not touch the floor of the shack. This eliminates any vibration which might cause unsteady signals. On a shelf above the motor-generator is the filter, which consists of a 30-henry Acme choke and eight 1 ufd. condensers. The choke is in the positive high voltage lead and four of the condensers are shunted across the line on each side of the choke. The 275-vole supply that is obtained from the machine is filtered by means of a 3-henry choke in the positive lead and a 1 μfd. condensers across the line both sides of the choke.

Although not shown in the photo, there is a 200 turn r.f. choke in each line and also one in each side of the 110-volt, 60-cycle a.c. supply line. These are back of the switch board. From left to right of the switch board are voltage control, of the motor-generator, Acme filament heating transformer, G.E. fiament heating transformer, and a 100-watt lamp which is used in a charging circuit for some Willard "B" batteries. These are in the cabinet back of the head phones. (See other photo.) From left to right on bottom of board are four switches which enable a change of the voltage on the motor-generator. Under these may be seen four fuses which are in all leads from the motor-generator to protect it from a burn

(Concluded on Page 70)

2 It should not be thought that this method will cure all key thump troubles. There are many cases where it has not proven so satisfactory and it is apparently in the same class with several other methods for doing the job. If the particular method happens to fit your conditions, it works. It it doesn't, try again with some other scheme. —Assistant Technical Editor.

Two Inexpensive Test Sets

(Continued from Page 32)

sealing wax poured into the base, thus filling it and holding the wires firmly in place.

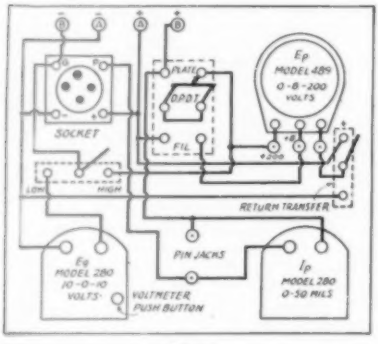


FIG. 2B

FIG 2. THE NEW SET, ADAPTED TO THE HIGHER VOLTAGE TUBES ORDINARY RECEIVING TUBES AND TO THE UX-222 SCREEN-GRID TUBE.

The range of the zero-center grid bias instrument reamins the same as in the small set but for some work could with advantage be extended by a multiplier or else replaced by an instrument capable of going up to 25 or 30 volts.

The switching system is such that all instruments are completely independent when the left hand switch is closed to the left and the others are open.

When working with a tube in the socket the left hand switch connects either the 10-0-10 volt or the 0-200 voltmeter between grid and minus A so that ordinary tubes, power tubes and the shield grid of the UX-222 may be handled. The right-hand switch permits the set to be adapted to receivers with return of B supply to either minus or plus A. The two-pole switch as before changes the two-range voltmeter from a filament voltmeter to a plate-circuit meter.

When using the meters independently the rubber-insulated prods are used, the terminals on the other end of the wires fitting either pin jacks or binding posts.

A voltmeter multiplier is shown above the set. This is not attached to the set normally but may be used to increase the range up to 500 volts so that the set will handle UX-210 tubes and everything below that.

After putting on identifying tags, the cords are braided together and placed on their proper terminals on the board. In use the suspected tube, or the tube in the suspected circuit is first placed in the test socket and the plug inserted in its place in the set. In this way it is possible to check readings for all the tubes or tube circuits under actual running conditions and if any of them doesn't show the necessary reaction it is a simple matter to run down the trouble. By placing the switch in the upper position we read the plate voltage, while the lower position gives the filament voltage. By disconnecting the first or grid lead at the top of the board we get the filament emission of the tube under examination on the milliammeter.

Recently I have added a second test board to my collection to take care of the necessary readings of the new 222 tube, together with other changes such as greater accuracy and polarity switches.

This set, illustrated in Fig. 2A is somewhat more complicated and constructed of more expensive instruments giving very accurate readings. It also differs from that shown in Fig. 1A by the addition of two single-pole double-throw switches; one of which is to change the grid meter from the regular one to the higher range meter in order to read the voltage of the shield grid of the 222 tube; the other switch changes the minus B line from plus to minus so that plate voltage will not be applied through the tube filament in sets which connect plus to minus and minus to minus.

The instruments in this latter set are as follows: E_p, plate voltmeter, Weston Model 489 high resistance 0-8-200, which may also be used for B Eliminator readings. E_g, grid voltmeter, Weston Model 280. 10-0-10. I_p, plate milliammeter, Weston Model 280, 0-50 mils. Figs. 1 and 2 illustrate the circuits of the two test sets.

Some of my friends who have built boards like mine have repeatedly told me that they were the best investment they have ever made, and do not know how they "ever kept house without them". So, in the hope that this meager contribution may be of some help to BCL members of the League I pass it on.

Strays

From 1BFX we get the following:

"The wx changes for the better. Wonderful DX reception. The whole world coming in R7 to R9. Everything rosy.

"Antenna comes down, 203-A burns all to blazes, new Jewell milliammeter likewise annihilated and in the same breath my dog dies of nothing in particular. All in the space of forty minutes.

"Can you think of anything to add?"

"If You Only Try——"

By A. L. Budlong*

MANY amateur transmitters today appear to be troubled—or rather the neighbors are—with key-thumps. For the owners of such stations, the solution of a bad key-thump case here in Hartford may prove interesting.

The other day the secretary of the live-wire listeners' organization in this city called us to say that an amateur in a certain section of the city was causing a lot of interference. Would we, please, see if it could be remedied?

We would. A scouting visit by the writer showed that a five-watt transmitter was raising hob with BCL receivers over a radius of about a quarter of a mile. The broadcast receivers were all good ones,

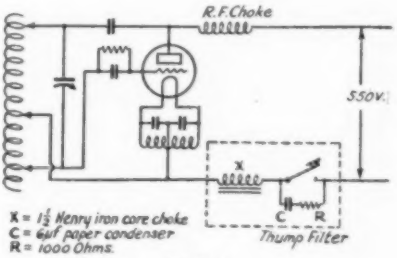


FIG. 1

which let them out. In spite of this, a key click emanated from the amateur station that was almost unbelievable in viciousness. At the house across the street—the worst place, naturally—a good broadcast receiver got tremendously loud clicks all up and down the dial, interfering even with the local broadcast station.

Several wavetraps gave zero improvement. Accordingly, armed with a suitcase full of miscellaneous apparatus, Handy and I went down a few evenings later to see what could be done to the transmitter. This proved to be a conventional Hartley affair, using a single 210 on 40 and 80 meters, with d.c. or r.a.c. on the plate. Key clicks were equally loud on either wave and with either type of plate supply.

We started in. Handy did most of the hard work, while the writer gained much exercise dashing across the street at frequent intervals to listen on the broadcast set there.

The key was in the negative supply lead. The click, of course, is due to the sudden shocking of the tube caused by an instantaneous rush of high voltage to the plate. If we can slow that down a little, say to a thousandth of a second, we can

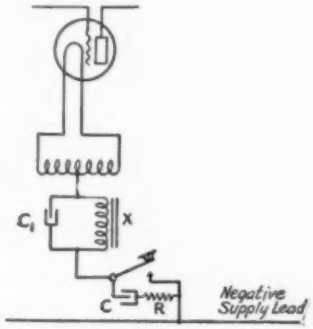


FIG. 2

probably eliminate the click. A choke in the supply lead will have the desired slowing-down effect when the key is closed, but cannot be used alone, because when the key is opened the inductive kick from the choke will cause a stronger click to be radiated. We must incorporate an "absorber" for this click. A condenser across the key will do this and by leaving a small supply of energy to be fed to the plate after the key is opened a resistance (500 to 1000 ohms worked best) in series with the condenser will let the condenser discharge slowly, and thus avoid trouble there. We put up such a system, as shown in Fig. 1.

A trip across the street showed less QRM, but it was not eliminated. This wouldn't do at all, as we were after total elimination. Accordingly, we did what should have been done in the first place; that is, shifted the key to the center tap connection.

The same filter was duplicated here, as shown at Fig. 2, with the addition of a 2-μfd. by-pass condenser across the choke, since the filter was now in the r.f. circuit also. This was fine. Listening all up and down the scale on the broadcast set failed to reveal a trace of thump, click or note. This was on 40 meters. We went to 80, and shoved the coupling as tight as possible. R.a.c went on the plate. Still no trace of interference. The click was wiped out.

*Asst. to the Sec'y, A.R.R.L.

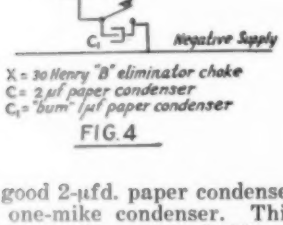
This was all very well, but the filter consisted of Handy's parts, and he wanted them. We could have specified a duplicate installation and let the owner buy the parts but that would take time. It was decided

X = 30 Henry "B" eliminator choke
C = 2 μf paper condenser

FIG. 3

to see if there was any material around the station that would provide a satisfactory substitute.

There wasn't much in the way of spare apparatus. Sorting through the junk-box produced one 30-henry "B" eliminator



X = 30 Henry "B" eliminator choke
C = 2 μf paper condenser
C_1 = "bum" 1μf paper condenser

FIG. 4

choke, a good 2-μfd. paper condenser, and a doubtful one-mike condenser. This was a far cry from the original filter system, comprising a 1½-henry choke, a 2-μfd. condenser, a 6-μfd. condenser and a 1000-ohm resistance, but we had hopes.

As a starter, the choke was put in the lead, but with no condenser around it. It was hoped that the distributed capacity would be sufficient to by-pass the r.f. The one good condenser went across the key. Fig. 3 shows it at this stage. When the set was operated, we could hear no thumps, but checking on the short-wave receiver showed that the tube was blocking at intervals of about a 50th of a second. Clearly, the choke was not satisfactorily by-passing the r.f., as we had hoped it would.

The good condenser was therefore put across the choke, and the leaky 1-μfd. condenser across the key, getting the combination shown at Fig. 4.

This proved to be absolutely as satisfactory as the more complicated filter in Fig. 2. Forty or eighty, loose or tight coupling, and r.a.c. on the plate—it made no difference. The click was gone, and as far as we know the installation is still operating satisfactorily.

The amateur now knows he can operate at any time without incurring the wrath of the whole neighborhood, and the neighbors have softened in their attitude toward amateur radio—and are not sending complaints to the Federal Radio Commission.

Not the least valuable feature of the case, however, is the demonstration of the fact that a thump filter can be made of parts with a wide variation from the "ideal" constants, and still do the work for which it is intended.

Official Wavelength Stations

THE Official Wavelength System furnishes a service coöperative with, but differing from, that of the Standard Frequency Stations 9XL and 1XM, which are also operated in accordance with plans made with the O.W.L.S. Committee. Contact with the O.W.L.S. is through Mr. D. C. Wallace, 6AM, who is also chairman of the committee. Mr. Wallace is continuing the practice of checking up all O.W.L.S. to make sure that they are really indicating their wavelength (or frequency) at the end of each transmission—and are doing so with proper accuracy; which is to say 2%. They do this in the course of regular operation and do not send calibration schedules as do the S.F. stations.

The list is as follows:

1AAC, 1AVW, 1AWW, 1BHW, 1BZQ, 1CCW, 1CK, 1KP, 1ZL, 1ZO, 2CLA, 2DS, 2MU, 2SZ, 2XI, 3APV, 3BE, 3XW, 4LK, 5XBH, 5ZAV, 6AKW, 6AM, 6BB, 6BCP, 6BGM, 6BMW, 6BQB, 6CAE, 6CMQ, 6CVO, 6LJ, 6QL, 6SX, 6TI, 6TS, 6XAG, 6XAO, 6ZE, 6ZZH, 6ZV, 7AGI, 7BE, 7BU, 7GQ, 7NX, 7QK, 7XF, 7ZX, 8AA, 8APZ, 8BAU, 8BZT, 8EQ, 8GU, 8GZ, 8XC, 8ZG, 9AXQ, 9BCH, 9BGK, 9BMR, 9CPM, 9CXU, 9DXN, 9EFO, 9EGU, 9ELB, 9FF, 9IG, nc1AE, nc2BE, nc3CO, nc3NI, nc3FC, nc4BT, nc9AL, eg2OD, eg2SE, Ireland 5NJ, oa2CM, and oz2AC. Crystal Controlled O.W.L.S.; NKF, 1AXA, 2BO, 2BRB, 2EF, 2WC, 4BY, 4XE, 6AOI, 6DLL, 8CMM, 8DAJ, 9AUG, 9BVH, 9UZ-NRRL, 9ZA, eg2NM, eg5LF and oa5BG. Standard Frequency Stations: 1XM and 9XL.

Radio Applied to Petroleum Prospecting

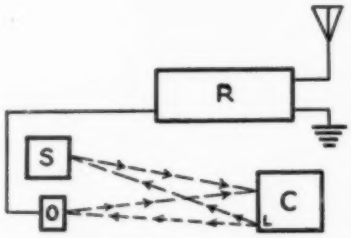
By Gerald R. Chinski*

AS the subject about to be discussed is probably more or less unfamiliar to most of the radio fraternity it will be well to begin with an explanation of petroleum prospecting by the seismic method.

The so-called "Seismic Method" is a term applied by Seismogolists and Geologists to the use of the seismograph[1] as a means of locating underearth deposits such as minerals, sulphur, and petroleum. It has been only since the World War that this method has been used to any extent in the petroleum field. As a matter of fact, war time developments on the seismograph as a means of locating big guns greatly facilitated its later use in more peaceful pursuits. Let us say here that it is not to be understood that this is a "sure fire" means of locating petroleum deposits anywhere. It is not. Very much depends upon the accuracy of observations and correct interpretations of records obtained as well as the geological conditions of the locality being sounded. And now with the aid of a few figures we will endeavor to explain the operation of this method.

In Figure 1, we have the essential apparatus for making a seismograph record. "C" is a camera carrying a strip of sensitized paper (similar to a moving picture camera) which moves past an apperture, accurately, at a known rate of speed. "C" also contains a source of light "L" which is projected through a narrow slit in order to make it produce a sharp light line on the sensitized paper, to which it is subsequently reflected. "S" is the seismograph itself which is equipped with a mirror system on its moving elements. The function of the mirror, of course, is to reproduce its movement on the sensitized paper by means of varying the angles of incidence and reflection of light from "L". The idea in placing "S" at a distance from "C" is, naturally, to obtain an amplified reproduction of the movements of "S".

The seismograph "S", being a mechanical instrument, receives its actuating energy from vibrations transmitted through the earth. It might be well to say here that most seismographs used in this kind of work are of slow vibration period. "O" is a simple electric oscillograph connected to the output of a radio receiver "R". This instrument in usual practice is nothing more than a telephone or loudspeaker unit equipped with a mirror system similar to that of the seismograph, and made as sensitive as possible to actuating energy consistent with good results. It is usually mounted next to the seismograph and reflects an image on the sensitized paper in "C" next to the image cast by the seismograph mirror. To complete the setup arrangement necessary to take a record one more thing must be mentioned, and that is the "timing device". This is installed in the camera "C", and usually is operated from the spring motor which is used to move the sensitized paper past the apperture. A pendulum swinging at a very uniform, predetermined rate, opens and closes a narrow slit between the light source "L" and the sensitized paper.



RECORDING STATION SETUP
FIG. 1

As time in this work is figured to one-fifth of a second, usually it is necessary

*Foley Bros. Radio Dept. Formerly with Roxana Petroleum Co. Radio 5CA, 1919 Harold Ave., Houston, Texas.

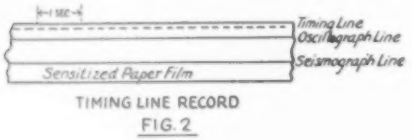
1. The seismograph (pronounced sais mo graff or sis mo graff is a device originally used for recording earthquakes of a mild or distant sort. The general scheme is that a large weight is flexibly supported in a frame which is secured to a heavy pedestal resting on the earth. If an earth tremor comes along the frame is shaken but the weight is held still by inertia. The *relative* motion between the moving frame and the stationary weight is used to operate a recording pen which marks on a moving film or smoked paper a line that later tells the observer what happened.

Many seismographs are operated year in and year out at government and school stations and the records obtained are such that it is usually possible to tell from the record of a single seismograph what the approximate distance and direction of a quake was, even though it is almost on the opposite side of the earth. Study of the records has taught us something about the inside structure of the earth —of which we know little enough.

Roughly the classes of seismographs are those which record vertical vibrations and those which record horizontal ones. The latter are almost invariably operated in pairs, an east-west one and a north-south one. To prevent recording local disturbances the machine is usually located away from traffic and the supporting pillar is carried through a sort of well to deep-lying rock or shale.—Tech Ed.

to have five exposures per second in the timing line on the record. A record taken of the timing line with the seismograph and oscillograph mirrors idle would appear as in Figure 2.

To prevent any exposure on the record except that which is wanted, the entire ensemble of apparatus and the operator are placed in a tent lined with red bunting to



TIMING LINE RECORD
FIG. 2

make it light proof. Some use has been made of a dark tunnel between camera and seismic and oscillograph mirrors, but the tent has been found much more practical.

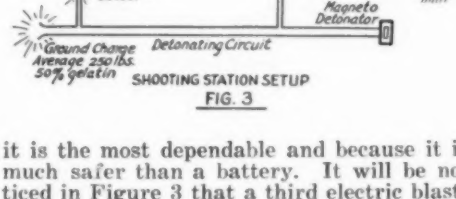
Thus we have outlined the recording station. In actual practice, several of these stations are used simultaneously. We will now outline the "shooting station".

The "shooting station" consists of a planted charge of dynamite and a radio transmitter. The quantity of dynamite used is dependent upon the distance between the shooting station and the farthest recording station as well as the geological condition of the earth intervening. In the Gulf Coast section of Louisiana and Texas, a charge of about 250 pounds of 60% gelatin is probably the average. In some cases, however, as much as 500 or 600 pounds is necessary. The distance between shooting and seismograph stations varies between two and eight miles.

The radio station is located some 750 feet from the charge, or "shot point". The charge is planted from ten to fifteen feet in the ground. This is done primarily to obtain maximum energy dissipation into the earth and secondarily for safety. In spite of precautions, some very large clods are thrown high into the air to curve downward and land with a vicious thud entirely too near the radio car, for one to feel absolutely safe. Once in a while a direct hit is made, which generally results in more or less damage. If the radio man and the dynamite crew are not good at dodging, they hide out under the cars. When no cars or other shelter are at hand, dodging is quite the thing. One soon becomes rather adept at the art of dodging. Very often, locations are made where it is impossible to take automobiles, such as up canals and bayous into swamps and marsh land. In such cases only that which is absolutely necessary for the station to function is taken along. One would gather from this that the very lightest equipment consistent with good results is highly desirable, which is certainly the case. Much more could be said along this line, but we will leave that for some other time and return to the subject under discussion.

A system is provided which will detonate the dynamite charge and break the radio signal at *practically the same instant*. A lag of more than one-fifth of a second in the system would render the records worthless unless it were known and constant. In that case of course it could be taken into consideration in the later record calculations. The most simple and best system with which the author is familiar will be explained.

The dynamite is always exploded electrically and the best grade of standard electric blasting caps is used. It has been found that if the caps are fresh and in good condition they will explode very uniformly at the same current flow. Thus one extra cap is included in series with the detonating system, as in Figure 3, the function of which is to break the negative lead of the "B" potential supply to the radio transmitter when it explodes. The regular magneto type of detonator is used because



SHOOTING STATION SETUP
FIG. 3

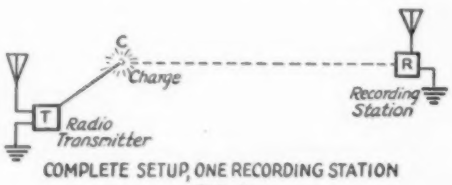
it is the most dependable and because it is much safer than a battery. It will be noticed in Figure 3 that a third electric blasting cap is connected in the detonating circuit. This is used to explode an additional 50 pounds of gelatin located at the "shot point", but not buried. It is called the "top" or "sound" charge, and its purpose will be explained later.

We will now take up the method of operation. In Figure 4 we have only included one recording station, as this is all that is necessary to explain the operation. A constant and modulated radio signal is being received at the recording station from the radio transmitter "T", at the shot point. This signal actuates the oscillograph at "R", producing a widening of the band of light appearing on the sensitized paper. A record of this addition on the paper would appear as in Figure 5a. This signal continues for a few minutes before the dynamite is exploded at the shot point.

About fifteen seconds before the scheduled time for the shot, the operator starts his camera and releases his seismograph mechanism so it will be free to vibrate when the earth wave arrives. He then remains

absolutely silent until the record has been made. First the radio signal stops, signifying that the charge has been exploded. A sharp break occurs on the record as in Figure 5b, when the oscillograph mirror returns to rest. The paper moves on through the camera and in a few seconds there is a wavering of the light beam making the seismic line on the record. This indicates that the earth wave set up by the dynamite explosion has arrived. The record is then complete provided that the exact distance between the shot point and the recording station is known. This can either be determined by surveying or by use of a pressure detector. The latter is used more extensively now as it does away with the expense of the former, which was a large item in this work. When the cone type seismograph is used it makes a very satisfactory pressure detector in itself. This simplifies things in that the same mirror system which registered the arrival of the earth wave also registers the arrival of the pressure wave through the air. The pressure wave arrives after the seismic "kick" has been recorded. In this way there is no confliction. The "top charge" formerly referred to, creates this pressure wave when it is detonated simultaneously with the ground charge. The result on the record would appear as in Figure 5c. Now we come to the point of explaining what all of the foregoing discourse really means.

In the first place, the whole thing hinges on the fact that a wave travelling through the earth will increase in velocity when encountering some harder substance such



COMPLETE SETUP, ONE RECORDING STATION

FIG. 4

as rock or salt formations. Now the presence of a "salt dome" is usually indicative of a petroleum supply in the Gulf Coast section of the United States. As there are no rock or other particularly hard formations here, seismograph results are considered quite accurate. The velocity of the wave through ordinary earth, that is, unaided by harder formations, is known and taken as a standard. If it is found, from inspection of the records, that the velocity of the wave has increased, the results are interesting. Repeat records are then made, and if no error is found, the presence of a "salt dome" is assumed. Its extent and form are then attacked by use of the seismograph, but we will not go into an outlining of the dome.

In Figure 6 we represent a complete record. It will be noticed that at "a" we have the "radio break", indicating the exact time the dynamite charge at the shot point went off. At "c" we have the arrival of the pressure wave indicated. The "timing line" furnishes an accurate check of the time elapsing between "a" and "c". Correcting for temperature and atmospheric pressure, the exact distance between the

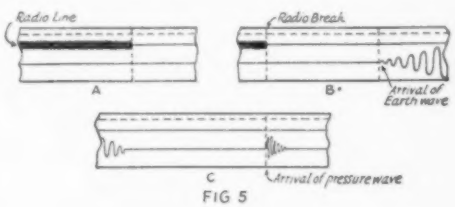
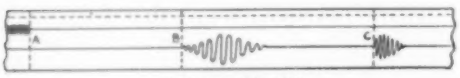


FIG 5

shooting station and the recording station can readily be computed. The space "a" to "b" on the "timing line" indicates the lapse of time between the "shot" and the arrival of the seismic wave. Knowing the distance and the length of time taken for the wave to arrive, it can then be determined whether or not there has been an increase in the velocity.

Next in importance to the seismograph, in this work, is the radio system. Without an absolutely accurate check on the time of explosion, the records would be worthless. As radio provides this check in a more practical and economical manner than any other method yet employed, its use is almost exclusive. While some exploration parties use only one-way communication, that is, a transmitter at the shooting station and a radio receiver at each of the recording stations, many now employ a two way system. The latter is obviously better despite the fact that it increases, somewhat, the over all weight of the apparatus to be transported, as it greatly facilitates the work of the party. In the former system all work, naturally, must be conducted on schedule. This is a great disadvantage, because in some cases it may be impossible for one or more of the recording stations to make location on time, due to some unforseen difficulty. Again, all the recording stations may make location ahead of schedule and have to wait until the specified time to function. All of this means a big loss of time, as well as the frequent loss of records. Where two-way communication is used, the additional investment in radio equipment is amply repaid in a decrease in the number of records lost, as well as the added convenience.

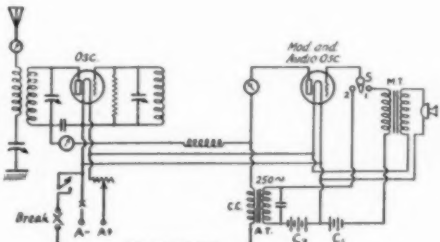
Much can be said of the design of radio equipment for this purpose, and if there appears to be sufficient interest in this line, we may take the matter up in another article. The conventional regenerative detector and two-stage audio amplifier sums up most of the receivers used, although late developments have actually brought about the production of a better set for the purpose. With the coming of the new screen-grid tube into general use, in this country, greater developments may be looked for in radio sets designed for this, as well as general broadcast work. Frequencies around 3,000 kilocycles are used extensively, and the development of a really efficient tuned radio frequency amplifier, at this wavelength, will mean much. Up to date, the author has found a simple superheterodyne receiver, employing one intermediate frequency stage with sharply tuned filter, using grid detection in both detectors plus regeneration in the first, to be much better for the purpose than any system he has yet seen. It does not seem at first thought that, for transmitting a signal over a distance of not more than



COMPLETE RECORD
FIG. 6

eight miles, either a powerful transmitter or a sensitive receiver would be necessary. As a matter of fact, this is neither right nor wrong. In the first place, the antenna input at the transmitter rarely exceeds 15 watts, and it is continually sought to reduce this by increasing receiver sensitivity. When working in the open, a fifteen watt antenna power 80% modulated and an ordinary regenerative detector and two stage audio receiver is satisfactory, but often when in wooded sections it is almost impossible to obtain a readable response on the record. Incidentally, it is highly desirable to be able to modulate the antenna input 100%. "Wobbulation" is caused, which tends to broaden the wave. This is desirable, however, as it makes for easy and quick tuning at the receiver, eliminating necessity for crystal control. Distortion amounts to nothing in results as long as the voice is intelligible. Figure 7 shows a schematic diagram of a field transmitter which the author has designed and found meets all requirements quite successfully.

The oscillatory circuit is tuned plate and grid which is familiar to all. Heising modulation is used. The constant current choke is the primary of the transformer T. Now, as it can be seen, this transformer also serves as an audio oscillator inductance when switch S is on tap No. 2, converting the modulator circuit into an audio oscillator. The primary of transformer T being the constant current choke as well as the plate inductance of the modulator tube, acting as an audio oscillator, the process of modulation is unchanged. Transformer T is designed to have an oscillating period of about 250 cycles with a minimum of distributed capacity. A greater bias voltage, as indicated at B2, is necessary when the modulator tube is acting as an audio oscillator to keep the input normal. An audio component of very steady frequency is secured and the radio output can be modulated 100%. Voice is used merely for convenience.



TRANSMITTER SCHEMATIC
FIG. 7

A.R.R.L. Technical Information Service Rules

Please help us by observing the following rules:

1. Keep a copy of your questions and diagrams and mention that you did so.
2. Number the questions and make a paragraph of each one.
3. Make diagrams on separate sheets and fasten them to the letter.
4. Print your name and address (not merely your radio call) on your letter. Don't depend on the return address on the envelope as this is destroyed when the letter is opened.
5. Don't ask for a comparison of the various manufacturers' products.
6. Before writing, search your files of *QST—the answer probably is there.*
7. Address all questions to Information Service, American Radio Relay League, Inc., 1711 Park Street, Hartford, Conn.
8. It is not essential to enclose an envelope as long as you supply postage and PRINT CLEARLY your name and address on your letter.

The DX Tape Measure

By Allen H. Babcock*

HOW FAR IS IT? This is the first thought when a really DX contact is made. Any one who has a working knowledge of Spherical Trigonometry will find the answer without my help; but so grave are my doubts that the average Ham ever can find an answer even approximately correct by the help of any one of the articles on this subject which have come under my notice, that I am now moved to break into print with what seems to me to be a complete answer in the form that will yield results in every case.

The only requirements are: the geographical positions of the two places; the ability to substitute these angles in the formulas that will be given; sufficient knowledge of Logarithmic and Trigonometric Tables to find the values of the functions given in the formulas; and finally, the comparatively rare ability to follow directions accurately, and to work without errors.

Geographical position is given as the latitude and longitude of the place expressed in degrees, minutes and seconds of arc. The seconds may be neglected in this kind of a problem. The latitudes, and the difference of the longitudes give two sides and the included angle of a spherical triangle, from which the side opposite the known angle can be computed; which is the distance between the places expressed in degrees and minutes. Since one minute of arc equals one nautical mile, (often wrongly called a knot), if the degrees are multiplied by 60 and the minutes added, we have the distance in sea miles; and since one sea mile equals 1.15 statute miles we have only to multiply again by this figure to get the answer we require.

There will be four possible cases:

1. Latitudes of the same name, that is, both north or both south, and the longitude difference less than 90°.

2. Latitudes of opposite names, one north and one south, and the longitude difference less than 90°.

3. Latitudes of the same name, and the longitude difference greater than 90°.

4. Latitudes of opposite names, and the longitude difference greater than 90°.

The first step is to find the longitude difference by subtracting the less from the greater if both are east or both west. If one is east and the other west, add them. If the sum is less than 180°, use it; if the sum is greater than 180°, subtract it from 360° and use the remainder.

Let a = the latitude of *the place nearer the pole.*
(You may work from either pole.)
b = the latitude of the other place.
C = the longitude difference.
c = the distance required.

CASE 1

It is required to find the distance between San Francisco, 37° 48′ North, 122° 23′ West, and an island in the Pacific at 14° 02′ North, 171° 20′ West. Here a = 37° 48′, b = 14° 02′, and C = 48° 57′.

$$\cos c = \sin a \sin b + \cos a \cos b \cos C$$

$$\begin{aligned} \log \sin 37^\circ 48' &= 9.78739 \\ \text{"} \quad 14^\circ 02' &= 9.38469 \\ \hline \text{antilog of} \quad 9.17208 &= 0.14862 \end{aligned}$$

$$\begin{aligned} \log \cos 37^\circ 48' &= 9.89771 \\ \text{"} \quad 14^\circ 02' &= 9.98684 \\ \text{"} \quad 48^\circ 57' &= 9.81738 \\ \hline \text{antilog of} \quad 9.70193 &= 0.50342 \end{aligned}$$

The angle whose Nat cos is 0.65204 is 49° 18′.

Then (49 x 60) + 18 = 2958 nautical miles or 3406 statute miles.

CASE 2

Required: the distance between a point in 37° 48′ N, 139° 43′ W, and another place in 14° 02′ S, 171° 20′ E. The sum of the longitudes is 311° 03′, which subtracted from 360° leaves 48° 57′. Here the values of a, b, and C are the same as in Case 1, but because the latitudes are of opposite name the formula now becomes,

$$\cos c = \cos a \cos b \cos C - \sin a \sin b$$

$$\begin{aligned} \log \cos 37^\circ 48' &= 9.89771 \\ \text{"} \quad 14^\circ 02' &= 9.98684 \\ \hline \text{"} \quad 48^\circ 57' &= 9.81738 \\ \text{antilog of} \quad 9.70193 &= 0.50342 \\ \hline \log \sin 37^\circ 48' &= 9.78739 \\ \text{"} \quad 14^\circ 02' &= 9.38469 \\ \hline \text{antilog of} \quad 9.17208 &= -0.14862 \end{aligned}$$

The angle whose Nat cos is $\overline{0.35480}$ is 69° 13′
Then (69 x 60) + 13 = 4153 nautical miles or 4782 statute miles.

*6ZD; A.R.R.L. Director, Pacific Division, 65 Market St., San Francisco.

If b and C become large enough, the second term will become larger than the first so that the difference will become negative. In this event the angle taken from the tables must be subtracted from 180° and this remainder will be the distance required. For example: if the two latitudes were 37° 48′ N and 37° 40′ S, and the longitude difference 85°, cos c would be –0.29808, the angle corresponding to which is 72° 39′ and this subtracted from 180° leaves 107° 21′, which is the distance required.

CASE 3

Required; the distance between a point in 52° 30′ N, 34° 59′ E, and another place in 18° 30′ N, 149° 20′ E. The longitude difference is 134° 30′. Our tables of functions of angles do not cover angles more than 90°, so that we must subtract 90° from this, which leaves 44° 30′ as the value of C in the formula. Also we must take out the sine of C instead of the cosine, and put the minus sign before this term in the formula. We have then, a = 52° 30′, b = 18° 30′, C = 44° 30′.

$$\cos c = \sin a \sin b - \cos a \cos b \sin C$$

$\log \sin 52° 30′ = 9.89947$
$\quad " \quad 18° 30′ = 9.50148$

antilog of $9.40095 = 0.25174$

$\log \cos 52° 30′ = 9.78445$
$\quad " \quad 18° 30′ = 9.97696$
$\log \sin 44° 30′ = 9.84566$

antilog of $9.60707 = -0.40464$

The angle whose Nat cos is -0.15290 is 81° 12′, which must be subtracted from 180° because of the minus sign, leaving 98° 48′. Then (98 x 60) + 48 = 5928 nautical, or 6826 statute miles, is the distance required.

CASE 4

Required; the distance between a point in 52° 30′ N, 14° 50′ E, and another place in 18° 30′ S, 149° 20′ W. The longitude difference is 164° 10′, from which 90° must be subtracted as in Case 3, so that C = 74° 10′ while a = 52° 30′ and b = 18° 30′. Since the latitudes have opposite names the sine term of the formula becomes negative, as in Case 2; and since the longitude difference is more than 90° the cosine term becomes negative, as in Case 3, and the formula now is,

$$\cos c = -\sin a \sin b - \cos a \cos b \sin C$$

$\log \sin 52° 30′ = 9.89947$
$\quad " \quad 18° 30′ = 9.50148$

antilog of $9.40095 = -0.25174$

$\log \cos 52° 30′ = 9.78445$
$\quad " \quad 18° 30′ = 9.97696$
$\log \sin 74° 10′ = 9.98320$

antilog of $9.74461 = -0.55540$

The angle whose Nat cos is -0.80714 is 36° 11′, which must be subtracted from 180° as in Case 3, leaving 143° 49′. Then (143 x 60) + 49 = 8629 nautical, or 9936 statute miles, is the distance required.

All these formulas have been derived from the one fundamental sine-cosine expression of spherical trigonometry, transformed to suit the individual cases, as follows:

$$\cos c = \cos a \cos b + \sin a \sin b \cos C.$$

C is the angle at the pole between the two meridians that pass through the two places, a and b being the lengths along the meridians from the pole to the places; in other words, their polar distances. The latitudes, being measured from the Equator must be subtracted from 90° to get the polar distances, or, what is the same thing, we may use them as given if we take the complimentary function values from the tables, provided all the angles are less than 90°. Our formula for Case 1 therefore becomes:

$$\cos c = \sin a \sin b + \cos a \cos b \cos C.$$

In Case 2, we have one side greater than 90° by just the amount of latitude given. In this Case the angle C was at the north pole, and the south latitude was 14° 02′, which is distant from the north pole 90° to the Equator plus 14° 02′, or 104° 02′, and the cosine of 90° + 14° 02′ equals –sin 14° 02′; also sin (90° + 14° 02′) equals cos 14° 02′; and the formula becomes:

$$\cos c = -\sin a \sin b + \cos a \cos b \cos C.$$

In Case 3, the angle at the pole is greater than 90°. As stated in the preceding paragraph, cos (90° + x) = –sin x; hence 90° was subtracted from the longitude difference, sin (C – 90°) was taken from the tables, and the second term was given the minus sign, which made the formula:

$$\cos c = \sin a \sin b - \cos a \cos b \sin (C - 90°).$$

In Case 4, the first term is the same as that term in Case 2, and the second term is the same as that term in Case 3, for the same reasons. The formula then is:

$$\cos c = -\sin a \sin b - \cos a \cos b \sin (C - 90°).$$

By using these four formulas as directed, the distance between any two points on the Earth's surface can be computed.

The Design of Variable Condensers for High Voltage Operation

By Bert E. Smith*

THE extended adoption of increased power by radio stations utilizing vacuum tube transmitters, whether commercial, broadcast, or amateur, has caused a corresponding demand for apparatus of all kinds designed to operate with maximum efficiency at the increased potentials thus made necessary.

The most difficult instruments to coordinate properly with the high power required are those which operate in such portions of the circuit as carry radio frequency currents. The potentials which these must withstand are frequently extremely high, and the currents also reach, comparatively speaking, immense values. Even small losses accordingly become of extreme importance and must be avoided or minimized with great care.

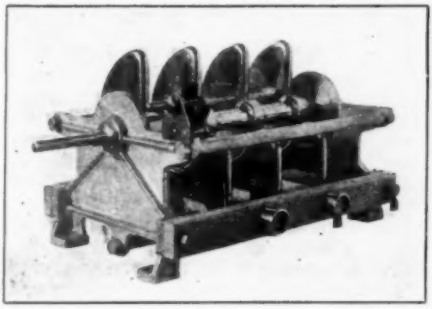
These circuits consist almost entirely of inductances and capacity, resistances in a properly built set being of a very low order, and this fact makes the reduction of condenser losses an important problem.

The general qualifications of variable condensers for such use are the same as the essentials of a good condenser of any variety—the requirements are very similar to those for ordinary receiver tuning controls. That is, they must be mechanically good, having ample strength to withstand mechanical stress, the bearings must be easy running and capable of unlimited use without perceptible wear, and the electrical characteristics must be as nearly perfect as possible. In order to carry high potentials successfully some dimensions must be comparatively large and the increased weight resulting from this size necessitates a correspondingly increased strength of frame construction.

Let us look first to the end plates. The usual stamped end plates used in receiving condensers and low power transmitting condensers become impracticable, as their strength is insufficient to keep them absolutely rigid under all circumstances and the least bit of end play which might develop under continued use might prove fatal to the alignment of the plates. It becomes necessary therefore to cast them, and a great deal of care must be taken and experimenting accomplished before they can be made dependable. Lightness demands that the material be not too thick, and strength requires thickness in some places, so a ribbed design has been adopted by some manufacturers as giving the maximum resistance to mechanical stresses combined with the minimum amount of metal.

The same conditions dictate that there must be at least three substantial supports between the front and rear end plates.

The plates must be of sufficient thickness to prevent perceptible vibration and the rotor shaft must be large in diameter in order to give the proper support to the heavy plates. Following the same line, unusually large and carefully constructed bearings become essential. At one end of the shaft a shoulder bearing can well be worked in to control alignment against a ball thrust bearing at the opposite end. This bearing should have only one job—that of supporting the rotor plates, and should be entirely independent of the electrical connection between the rotor and frame.



A NEUTRALIZING CONDENSER

Note the unusual thickness of plates, and the shields around the stator support screws. Several of these are used in the trans-Atlantic Telephone Station at Rocky Point, L. I., for neutralizing the R. F. amplifiers.

The introduction of the current into the rotor can be by various means. We have just eliminated the route through the bearings—the necessity for proper lubrication introduces an element of uncertainty in resistance which makes this method absolutely impracticable. The next thought is a pigtail, but due both to its tendency to wear and the possible variation in inductance, this also is ruled out. The third and most practical means is to attach to the rotor a heavy brush which operates against a special contact ring on the end plate, and as size is comparatively no object, sufficiently heavy

*Allen D. Cardwell Mfg. Co., 81 Prospect St., Brooklyn, N. Y.

material can be used here to insure the retention of pressure indefinitely.

The question of supporting the stator is so closely linked up with the electrical characteristics that we shall go into it later when dealing with them. The one important requirement is the method of mounting securely the huge mass of metal we have

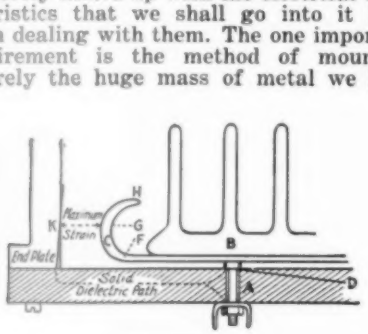


FIGURE 1

obtained. This is among the least of our difficulties—brackets of substantial size can be made integral with the supporting posts, and arranged for attachment to a panel, or by means of mounting feet built into the end plates, the condenser can be attached to a baseboard.

From the electrical view point the problem of design is tremendously more complex. Electrostatic fields which are of negligible strength in condensers for low voltages, become of great significance, and

A STANDARD MODEL WITH A VOLTAGE BREAKDOWN APPROXIMATING 7500

This is the type usually used by ordinary 500 watt broadcasting stations, and in most amateur installations exceeding a quarter kilowatt. A similar model with a split stator is employed by the R. C. A. and its affiliated companies for experimental short wave transmission, both telephone and c.w. By placing the two stators in series a voltage breakdown almost double the original is obtained.

many weaknesses which would be imperceptible under any ordinary circumstances manifest themselves immediately.

Insulators and conductors obtain their characteristics purely through the properties of their molecular structure. Where some electrons in the atoms composing the material are free, the material is a conductor. In non-conductive material, so called, we have electrons which are not free. They are so tightly bound that only extreme electric pressure can dislodge them, although the structures themselves may be forced out of shape.

Such materials as hard rubber, air, bakelite, pyrex, et cetera, are of this type. There are practically no free electrons in insulators, although electric pressure can be applied, and the resulting field noted at a distance in the insulator, much in the same manner as a group of billiard balls may transmit the power of the impact from the cue ball without moving themselves. It is by distorting the normal component of these atoms in the dielectric that we can make a condenser store electrical energy.

The rapid reversal of the pressure in a dielectric will cause more or less heating effect according to the resistance which the

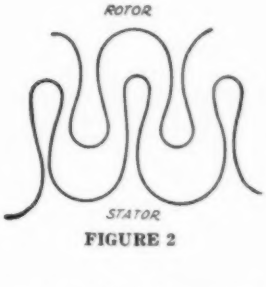


FIGURE 2

electrons of the dielectric oppose to having their normal positions shifted. If the impressed voltage is too great it may force a discharge through the dielectric. This may manifest itself as a spark discharge which will actually puncture the dielectric, or may show up merely as leakage. Air is of such a nature that this leakage is almost impossible and any breakdown will be by means of a flashover, whereas in a solid dielectric the leakage loss is always present.

The next effect to be observed is that some current may be dissipated through the resistance of the plates. As previously observed, this is not likely to amount to much.

A third loss, hysteresis, is caused by the delay of some poor dielectrics in returning the atomic structures to their normal positions, causing a similar delay in delivery of the stored charge. When we are working with frequencies of ten million alternations or thereabouts per second the elimination of this delay becomes of great importance.

It becomes obvious that if air, which is practically perfect and has no appreciable losses, can be utilized as the dielectric, we will have a condenser with no important losses. Unfortunately, however, we cannot

use air to support each stator section and we must utilize a solid insulator for this purpose. It is also quite apparent that if we can keep this supporting material entirely outside of the electrostatic field it will not cause any additional losses.

Another property of dielectrics is the dielectric constant. This is entirely independent of the loss factor and varies from unity with air to as high as sixteen with celluloid. In other words it takes one sixteenth as thick a body of air to cause a condenser to have the same capacity as would be the case if celluloid, having a dielectric constant of sixteen were used. Hard rubber has a dielectric constant of two or three. Pyrex has a value of approximately six. Bakelite varies from four to eight.

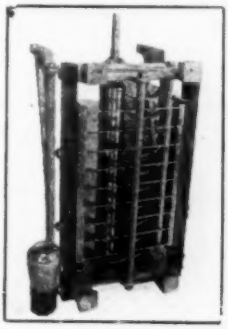
In order, therefore, to transfer the dielectric strain as much as possible from the solid to the air it is necessary for the path through the insulation to be at least as great as the average air distance multiplied by the dielectric constant of the insulation. That is, if hard rubber is used the distance through the hard rubber must be more than twice that of the air separation, and if pyrex is used it must be more than six times the air distance.

Let us now refer to Figure 1, which shows the method of stator support. The main block B which supports the stator is held away from the strip of insulation A except at the points of actual support C. This serves the double purpose of interposing an air path between the conductor and dielectric and of removing the dielectric just a trifle further from the field. This construction is sufficient where comparatively low potentials are encountered, but where the electro-motive force is of a higher order even further precautions become necessary.

It is a well known fact that the density of electric charge on a conductor is greatest when the exposed curvature is sharpest. If we apply this principle to the metal of a condenser we will find that there is a higher density of charge at all corners and projections than at points where the surfaces are flat or slightly rounded. For this reason it becomes advisable to reduce these areas of excessive pressure by removing them, which may be done by carefully rounding off all corners, keeping the radius of the surface at half the thickness of the conductor. For the same purpose all parts subject to strain should receive a high polish, in order that there may be no points or irregularities from which a brush or spark discharge can take place.

We have already mentioned the necessity for a complete removal (or as complete as possible) of the solid dielectric from the electric field. Referring again to Figure 1, it will be noted that the stator supporting block B is covered by a curved shield C, and once again between this shield and the dielectric support A there is interposed an air space. The only points of contact between the electrode and the solid insulation are at the points where the supporting screws pass through the insulation, and even here that part of the screw which passes through the insulation is highly polished, and a minute air space surrounds it except where the spacing washer "D" and the nut are attached.

On the shield block C the only sharply curved portion is at H, and since this points back toward the structure B and is at the same potential as B, the tendency to form a brush discharge is greatly reduced. The part that comes nearest to the end plate K is so slightly curved that here, when the exposed electric field is greatest, the danger of discharge with the air is minimized.



A SLIGHTLY LARGER MODEL BUILT FOR A 1-Kw. BROADCASTING STATION TANK CIRCUIT

The capacity of this is about 200 picofarads at a breakdown around 10,000 volts.

As long as the maximum dielectric strain is across K G, if we maintain a much longer path through the solid dielectric we may eventually reach a point in which we could use any of the so-called insulators regardless of the poorness of their quality. Nevertheless, the better the dielectric, the less will be the loss from heat generated by hysteresis, and the safer we will be from mechanical trouble in our insulators.

If we drive two rods into a box full of moist earth and connect a source of current to them we shall find that we have a definite amount of current flowing between them. If we now remove say three quarters of the earth in the box we shall find that our current is smaller than it was before. A somewhat similar condition is found in the insulation used on the condenser. It may seem a poor analogy at first glance because the moist earth is quite obviously a conductor and the insulation material on the

(Continued on Page 66)

Experimenters' Section Report

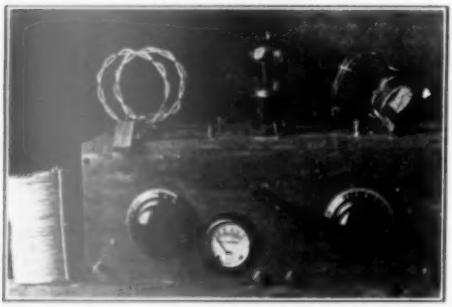
THE following is the third of the Experimenters' Section progress—reports announced in the last issue. More are to follow in early issues.

A Portable Transceiver

By Herman Radloff*

I TRIED to write a complete resumé of my 5 years of dabbling with the problems and pleasures of portable stations but on reviewing the result of my efforts I was positive that a few general statements and a description of my present outfit would be of more practical value.

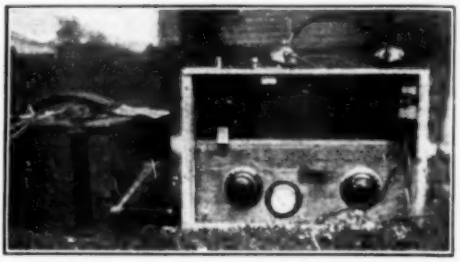
There are many situations in which one sees an opportunity to use a portable station to advantage and although the general problem remains the same the actual set must be considerably modified in each case to fit the limits of weight and size which are set by the method of transport. The nature of the power supply must of course also vary.



FRONT VIEW OF THE "TRANSCEIVER" IN ONE OF ITS MANY DIFFERENT FORMS.

Some of the preliminary coils are shown. The transmitting circuit is at the left, the receiving circuit at the right. The handle at the top center operates the send-receiver switch. The 0-25 milliamgrid meter is used in tuning the transmitter. The hinged tickler sets the regeneration exactly enough for the band on which one is working.

My set is very nearly always taken along on auto trips among Minnesota's 10,000 lakes. Here we are limited mostly as to space. I accordingly constructed a "transceiver" in, and on, a hard maple case 15½ inches long by 5½ inches wide and deep. This needs an additional 6 inches "head room" to accommodate the tube and inductances and that space is allowed in the outer cabinet. The inductances plug in; pup jacks are used. It is convenient to be able to QSY any time you feel like it, and the set is also readily available as an emergency transmitter.



THE SET READY FOR THE ROAD

The outer case carried the set with coils and tube in place. The receiver B battery is the white object at the upper right.

At the left is the "Megger" which is used as a power supply.

Another problem will always rear its ugly head. That is vibration and rough handling with its accompanying breakage of connections, nuts unscrewed and, possibly, the complete destruction of your brain-child. My solution is to use only the minimum number of parts and make all connections of fairly heavy strip copper as far as possible and to attach these rigidly to the frame by heavy brass bolts.

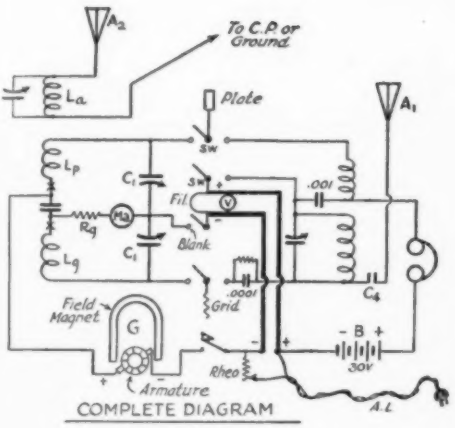
I chose to make the set a "transceiver" with a 4-pole double-throw cam switch to change over and decided on the Colpitts series feed circuit for the transmitter because it adapted itself so readily to my scheme of connections.

The receiving circuit is the old reliable "2 circuit" autodyne. Since one does not need radio frequency chokes in my particular version of the circuit and regeneration is not a critical adjustment—I find this to fit in nicely with my purpose to use the minimum of parts and space.

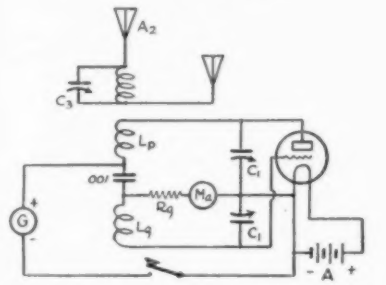
The tubes used are 201-A, VT-14 and UV-202. The filament supply is easily obtained from the electrical system of the car. All of these tubes work well in the set with the preference for the 201-A as it gives a greater output with least filament current. Unfortunately it does not last as long as the tubes with tungsten filaments.

As you will see in the photos, the condensers and switch are enclosed. This is to protect them from *dust*. Dust accumulation is the greatest annoyance I had to contend with until I tore out enough plates to give a clearance of *at least* 3/16 inches be-

*Member "X" Section, 9AIR, Route No. 2, Sleepy Eye, Minnesota.



COMPLETE DIAGRAM



COLPITTS CIRCUIT WITH SWITCH TO LEFT

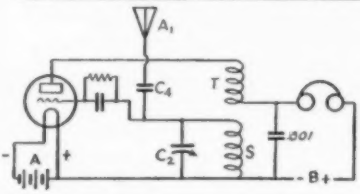
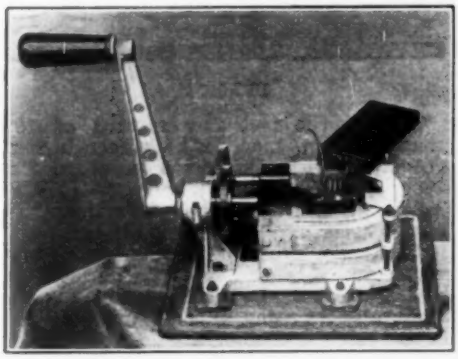


PLATE TICKLER CIRCUIT WITH SWITCH TO RIGHT

FIG. 1. COMPLETE DIAGRAM

Lp—Lg Split transmitting inductance (plugin)
La Antenna coupling coil
S Receiving tuner coil (plugin)
T Receiving tuner tickler (hinged)
C1 C1 Double Cardwell variable condenser
C2 Federal variable condenser
C3 Antenna tuning condenser (not built into set shown by photos.)
C4 Adjustable antenna coupling condenser for receiver.
The fixed condensers have their capacities marked.
V Filament voltmeter. (Present set omits this and rheostat)
Ma Grid milliammeter
G Hand driven generator
A.L. A supply line equipped with plug to fit socket connected with car battery.
A1 Receiving antenna.
A2 Transmitting antenna. The same antenna may be used for both purposes by adding another switchblade, provided it is so done as not to upset things.

tween rotor and stator plates. Naturally this gives one a very restricted tuning range; in fact, it just covers our bands, but what more *does* one want? The receiving tuning condenser consists of 4 plates—2 rotor and 2 stator, while the trans. condenser has 3 plates *per section*, 2 stator and 1 rotor. A Cardwell dual condenser is used here. The internal capacity of tubes differs



THE "POWER PLANT" REMOVED FROM ITS CASE AND WITH THE SMOOTHING CONDENSER DISCONNECTED TO PERMIT SHOWING THE BRUSHING AND ARMATURE.

The generator is a 1500 volt magneto affair but the more common American "Meggers" use 500 or 1000 volt generators which are quite as useful.

enough to be of importance when they are used in parallel with tuning condensers of such small capacity as these. The 201-A and 202 are very nearly identical but the VT14 tube has a capacity lower than these. When using a VT14 with inductances designed for 202 the resulting frequency was always higher than our legal assignment and contributed not a little to my vexation —before I located the reason.[1]

The right values of inductance were found only after a period of cut and try. It took an awful bunch of wire before I had everything right for 80-, 40- and 20-meter operation. I then took the measurements of these coils and substituted Hammerlund space wound rigid coils.

The power supply for the transmitter is the generator of a Marconi "Megger" that I was fortunate enough to buy once. It delivers 1500 volts and 120 mils—180 watts with a strenuous manipulation of the crank. To generate 30 watts, or what we generally put into the portable, is not such a task. This baby generator has a d.c. output and

(Concluded on Page 68)

1. The use of a larger tuning capacity will tend to decrease the tuning effect of different tubes and also to avoid the 20-meter "yooping" which is mentioned later. The ideal from both standpoints is to approach such C/L proportions as are discussed elsewhere in the last issue by Beverly Dudley while at the same time maintaining the condenser spacings which have been found necessary.—Tech. Ed.

I.A.R.U. NEWS

BELGIUM

"During the last few months of 1927 many Belgium amateurs have been in regular contact with the Norwegian ships, *Tennesse* (AWL) and *Thallatta* (AWV). Communication has been on 32 meters. The *Thallatta* is on her way to Japan.

"The general conditions for wave propagation are very bad for transmission in a westerly direction, putting us at a disadvantage in working U.S.A. stations. It is much better and sometimes quite good for easterly work, the Aussies coming in strongly each day at about 1330 G.C.T. 4AU who is excellently situated in plain country and has ample power, reports that OZ, OA and AI stations are heard regularly from 0700 to 2100 and he keeps constant contact with them all day long, passing from the 20- to the 32-meter band when that becomes necessary.

"We recently heard xoa5AM when she was being towed from the Virgin Islands to Europe, announcing that she had been dismantled by an awful storm which disabled her to an extent where she could not proceed of own accord. (See page 52 of January, 1928 issue, for complete details of her trip to the Virgin Islands.—Assist. Tech. Editor.) Her "boy at the key" wanted to be reported to his friend oa5AG. eb4FT who was listening at the time, took a chance of getting the information across by calling Australia. Imagine his astonishment when he heard the proper man, oa5AG, replying to his call! The contact was a good one and the entire news passed over to its destination in short order. Very nice work!

eb4WW IS LOCATED AT 17 BOULEVARD FRERE. ORBAN, LIEGE, AND IS OWNED AND OPERATED BY G. REGNIER

The transmitter employs two French type E6 tubes in a Mesny symmetrical tuned grid, tuned plate arrangement. The input to the plates is 150 watts obtained from a 2000 volt transformer and a bridge type chemical rectifier. A Zeppelin antenna operated at a harmonic is the radiator. eb4WW has worked 54 countries and is a member of the WAC Club.

"4WW has recently been reported as being heard by aj4ZZ, thus being the first Belgium to be heard in Japan. 4UU worked xep1AM when the *Adamastor* was at Shanghai. The *Adamastor*, a Portugese warship, is using a Marconi 200-watt valve transmitter employing a single MT-4 tube.

"The Reseau Belge is growing fast and sends to its many friends in the I.A.R.U. its best wishes for a successful radio year during 1928."

—*Paul de Neck, President, Reseau Belge.*

CHILE

The following report on conditions in Chile has been supplied to us by sc2AS, being relayed thru nu6AM.

"Hot weather and QRN make receiving conditions rather bad in Chile at present, although in spite of this, NU stations still pound through in fine style on the 40-meter band. Few NU and no European signals have been heard on the 20-meter band for about a month now.

"We understand that sc3AG has taken his station to bits with the intention of going to Argentina and settling there. We would surely feel it very much if we lost him, since he is one of our best amateurs. Anyhow, if he does go, we can be certain of having a good friend among the SAs.

"Most of our stations are in a calm now on account of the summer heat and QRN but all will be going strongly during the coming February International Tests.

"Two of our stations, 2AS and 2AH have received titles of 'Member of Honor of the EAR Association,' the Spanish I.A.R.U. Section, for having worked Spain during a contest organized by that organization, sc2AS was the first Chilean to work Spain."

—*sc2AS.*

ENGLAND

"Conditions have been very strange towards the end of December and even the

(Continued on Page 72)

Calls Heard

KDEI, Yacht *Lark*, Shortey, Operator, Off Gibraltar

1avb 1act 1kx 1um 1tp 2ary 2avw 2amt 2pl 2avk 3axt 3cva 4td 4cx 4ac 5md 8cx 9rc.

S.S. *Margaret Dollar*, KDUV, E. O. Schwerdfeger, Opr., Docked at Cristobal, C. Z.

(Heard January 7, 1928)

1add 1cmf 2ahi 2bf 2rs 3ag 3aim 3aps 3cc 3ht 4bl 4cf 4ge 4rp 4tk 5acl 5aqq 5ayd 5gr 5pr 5rg 5we 6ad 6ard 6ary 6bil 7adb 7ckc 8alu 8ank 8avp 8bti 8cbf 8hx 8uy 9aca 9arn 9au 9aue 9avv 9baf 9bca 9bht 9cv 9dr 9dko 9sk ac-1ar nc-3mp agj glk glq famj irl pep pkx xcf xom.

Mr. Sherman, Chief Operator, S. S. *W. W. Mills*, Enroute Boston from Texas

(40 meters)

Off Florida Coast—Dec. 23rd, 1927

1adl 1bjc 1bux 1cdi 1ckc 1rp 1zza 1ah 1mx 2ahg 2ama 2amv 2bqh 2di 2hr 2jc 2wi 2xs 2bc 3acm 3ag 4ab 4acv 4cu 4cv 4lk 4oc 4qe 4tb 4tu 4sv 5ayl 5rg 8brc 8gi 9dfj 9dku 9mz 9sk glk fu uk uc.

(Off Georgia Coast—Dec. 24th)

1awa 1ga 2ab 2agn 2bir 2rs 2md 4nl 5ama 5kg 6am 8apm 8bto 8bth 8cfr 8czu 8dod 8dqb 8dpo 8drs 8fb 8te 9dlm 9dqx 9dyd 9exe 9hb vci pjd spu hjg glk wtt 2xs.

(Off Carolinas—Dec. 25th)

1ang 2afr 2ann 2atd 2ber 2bvh 2aqd 2aon 2fs 2kr 2lh 2cc 2cty 2fs 2nic 2ps 2qu 2sm 2tp 2tt 3aeb 3ajd 3bno 3bsj 3hg 3hk 3jn 3kn 3vg 4ac 4acn 4hm 4qz 4rn 4rq 4sx 5ag 5amg 5ase 5ge 5jc 6bfp 6cww 6dmd 6xi 8adg 8att 8axx 8aud 8bev 8bjs 8byt 8dbs 8dbc 8bjs 8byt 8dcm 8cvs 8cfm 8eq 8zg 9avp 9axq 9bkk 9bx 9bxk 9dny 9eqc 9hi nc-2bg oo-7rm nat.

(Virginia—Dec. 26th)

1abz 1aod 1aqt 1aun 1br 1ctp 1cmz 1ia 2amh 2aoh 2aol 2bcc 2bgt 2bh 2bck 2ctn 2fd 2cg 2baa 2sq 3ajd 3avm 3apx 3aso 3ag 3bkw 3ec 3ee 3cd 3ht 3qe 3tf 3sz 4acz 4abl 4uk 4ei 4uu 4si 5kc 5gr 7rc 8brh 8pk 8czu 8ok 8bhz 8acr 8bto 8cxi 8avp 8cem 9dyf 9aio 9cn 9qc 9cos 9mn 9cjo 9crj 9ave 9bcf 9cca 9elb oc-fpl nc-2al ew-h4 nc-4cg ef-8ba der.

(North of Boston—Dec. 27th)

1aeq 1bca 1rf 1wl 2apu 2are 2awu 2ayb 2bgo 2bhr 2bsc 2cub 2eq 2kx 2rd 3adi 3afx 3aib 3apn 3ani 3ce 3uk 3rg 3pr 8agk 8ahk 8asp 8bni 8cau 8cfv 8axz 8dhy 8don 8dhy 9dvt nc-2bb rjc.

A. F. Barnette, S. S. *St. Heliers*, Aruba, D.W.I.

1ag 1air 1aqp 1aqt 1awm 1bax 1bdq 1bgh 1bgq 1bhm 1br 1bux 1bxh 1chg 1ckp 1cnp 1fl 1rd 1ut 1xv 2abe 2adl 2ag 2agb 2ahg 2aib 2ale 2alu 2amj 2apd 2apg 2aq 2aqo 2ass 2avw 2awn 2bco 2blm 2cc 2ctm 2czr 2dh 2dr 2gp 2jc 2qu 2rs 2rz 2sz 2tp 2tt 2ty 2uo 2uy 2xnf 2xq 3aiy 3aks 3au 3bqj 3cgt 3ckj 3gi 3kt 3qp 3qt 3am 3wm 4aba 4acn 4cq 4ha 4jd 4li 4mau 4oo 4oc 4pk 4qf 4qv 4tk 4vh 4wsa 4wsm 4wsz 5agl 5aky 5aq 5aqe 5aqx 5arf 5as 5ats 5auz 5axs 5ayf 5ayl 5bg 5kz 5pt 5uk 5uw 5yb 5ybd 6agg 6ahn 6alz 6am 6ajm 6apb 6asd 6axq 6bam 6bgb 6bkd 6bvv 6bxu 6boj 6cih 6cin 6cmq 6cww 6czz 6dap 6dgy 6dkx 6dlj 6dpu 6gg 6ju 6pn 6qo 6nw 7ail 7bm 7ek 7vh 8agk 8akv 8alu 8amo 8apt 8aul 8awu 8axz 8bek 8bf 8bfg 8bk 8bts 8bwn 8bwr 8ccs 8cfl 8chz 8cjb 8cnt 8cqi 8cxh 8dac 8dbh 8dbj 8dlv 8dsa 8dss 8dsy 8eq 8fb 8tw 8vd 8wer 8xe 9abu 9ahz 9aun 9axh 9bad 9bca 9bjn 9bls 9bsh 9bxi 9cbc 9cde 9cej 9cfn 9cg 9civ 9cjw 9cmu 9cmv 9cph 9cpq 9cpr 9crd 9czh 9czt 9dga 9dmb 9dnd 9dps 9dwa 9dwq 9dxp 9eaj 9efy 9eht 9ir 9kd 9mz 9pg 9ra 9so oz-2ay oz-2bp oz-3aw oz-4am nc-1ak nc-2be nc-2br nc-3cs nc-4k nc-8ac nq-2ac nq-2jt nq-7cx ng-uf sb-1ah sb-sng ef-8xo fm-8mc anf agj gbi gbj ohk pof.

Hla Aung, 434 Lower Main Road, Moulmein, Burma

(Heard between Nov. 16, 1927 and Nov. 22, 1927)

ai-3kt ai-2at ae-pae oa-5hg op-3bw op-1hr op-1dr op-4aa op-4ak op-1gz op-1mr xom agj agj dwa agp vompk kzet kzed kbp agw hva ksw.

oz-2BJ, Allan Evans, 269 Taranaki St., Wellington, N. Z.

1bbo 1cmp 1xv 2abe 2awf 2ay 2bi 2cei 2cvj 3buv 3cc 4jm 5kg 5ry 5uk 6aij 6alz 6am 6apd 6arr 6ave 6awy 6bgb 6bhs 6biu 6bjl 6bkd 6boy 6bsn 6clx 6cwl 6cww 6cqo 6czz 6dfq 6dfw 6dgt 6dkt 6dor 6hm 6jn 6mm 6mu 6rn 6ss 6zbw 7agr 7alk 7ok 8bwr 8sx 8xe 9cn 9cjh 9dfz 9dk 9dr 9ell 9xi nc-4cc nc-4cu nr-cto oh-6aed oh-6avl oh-6boe oh-6ch oh-6dey oh-6dju oh-6dki oh-6dqq oh-6hii oo-bam sb-2aj anf arex bgs hox hza xom.

W. H. Ramsten, S. S. *Hoxbar*, Cartagena, Colombia, S. A.

1cna 1akx 1pa 1adb 1ic 1bkp 1lx 2aqg 2hq 2bdc 2bvh 2cuq 2cuf 3us 3ag 3acb 3alq 3kp 3afl 4vh 4gw 5yb 5cx 5ayl 5aga 5ot 5acl 5lv 5adp 6awt 7ant 8avb 8coj 8ac 8hc 8dpa 8akk 8am 9crd 9bmu 9eaj 9bcf 9dsz 9erh 9epg 9cev 9ekn 9cuv 9aid 9bnf.

np-4RX, A. Percy, Box 241, Ponce, Porto Rico

(20-meters)

1aao 1sz 1byv 2bsc 2ags 2ajn 2alm 2md 3nv 3jm 5jr 8adg 8clp 8cke 8cgs 8cpg 8dmx 8cbi 9as 9cmz 9dod 9ef 9cu 9pm 9dwe 9efh nc-1ar nc-2al nc-3bt nr-2fg eb-4rs eb-4zz ozz wgt.

1AGE, 42 Kernwood Ave., Beverly, Mass.

6ags 7bg ef-8fd ef-8et fe-8cp ef-8dmu ef-8ba ef-8az ef-8jc ef-8ix ef-8eo ef-8fm ef-8imr ef-8dmf ef-8ud ef-8bir ef-8cc ef-8fxf sb-1aw sb-1ic sb-1ao sb-2ay sb-2ad sb-2al sb-1br sb-2an sb-1ah ek-4coa ek-4oa ek-4dba ek-aeq ek-4aap nq-2ot nq-2cf nq-2jt nq-7cx eg-5by eg-5ml eg-5ls ep-1ag ep-3am nb-be3 eh-9aq nr-2fg ee-ear 65 fm-8psrv nn-1nic nm-9a oz-1fq su-2ak es-1fp eb-pl ril jj.

1ASR, St. Pauls School Radio Club, Concord, N. H.

5aac 5adv 5afg 5afi 5akp 5aqe 5aqf 5ase 5atf 5atm 5ats 5ayl 5gc 5ge 5gr 5hz 5kd 5kg 5px 5sh 5ts 5ut 5yb 6aae 6agr 6ahs 6anc 6apd 6asm 6atu 6avj 6baj 6bdl 6bhc 6bjq 6bjv 6bkn 6bpc 6bqo 6bts 6buf 6bwk 6bzn 6cdw 6cgr 6che 6cp 6ctc 6cty 6cwl 6czt 6dev 6dfv 6dgm 6dgs 6dgy 6dh 6dhg 6dje 6dkt 6dma 6dml 6dod 6eu 6ff 6ih 6ju 6kg 6nx 6uo 6wk 6xo 7aac 7ach 7afu 7ail 7al 7dd 7fe 7if 7io 7ok 7sj na-rxr nb-be3 nc-4ar nc-4eh nc-4lv nc-5go ne-8ae ne-8af nh-ca nm-9a np-4sa nq-2cf nq-5ev ea-cm eb-4au eb-4ax eb-4cb eb-4rs ee-ar10 ef-8fd eg-2ch eg-5by eg-5ma eg-5ml eg-5sw eg-5yk eg-5yx eg-6ia eg-6rw eg-6vr egc-6kd egi-2it ek-4aap ek-4abv ep-1aa fm-8psrv fo-a3z fo-a7n fo-a8p on-dku wnp wvw waj waq wuck ngm arn agb caca ocrs viy irl.

(Continued on Page 82)

Correspondence

The Publishers of QST assume no responsibility for statements made herein by correspondents.

72 Gardner Street,
Allston, Mass.

Editor, *QST:*

Since last sending you information regarding amateur activities during the recent New England flood, reports have come in from straggling stations, some of which were located in the flooded area, most important of which is that of 1BDX and I am enclosing herewith a copy of a letter which accompanied his report. This letter was read before the Boston Post of the American Signal Association on their last monthly meeting.

About fifty members of the Post were present and 1BDX was recommended for honorary membership in the Boston Signal Post and the Post further agreed to rehabilitate his 50-watt transmitter.

—D. S. Boyden, 1st Lieut.,
Signal Corp Reserve

P. O. Box 209
Barre, Vermont.

"1st. Lieutenant D. S. Boyden, Sig Res.
Dear Sir:

"Following is the requested report on activities at 1BDX during the flood emergency.

"On the first day of the flood at about 3.00 p.m., the excitement began when I had a narrow escape from a store basement as a wall collapsed filling up the basement with water in a few seconds and killing the two men I was working with. I had another close call later in the evening. While working in about a foot of water on the first floor, a trap door cover floated off leaving quite an opening in the floor. I fell thru this opening down into the basement, but luckily came back up thru the same hole and climbed out.

"I was ordered home at about 1.00 a.m. and told to change clothing, eat, etc. When I had done this, I began a series of *QSTs* giving information on the flood. I don't know just how this dope got thru as I have had no reports on it.

"No QSOs were made until later that morning. When I first offered my services, the people must have thought it was the "Bologna" or something. However, when I began returning prompt answers to personal messages, everyone made a rush to get their dope through.

"Then I didn't get a chance to eat, sleep or anything else. The first relief I got was when Birnie of 1AVZ (not operating) and Hunt, a former operator from Lancaster, New Hampshire, came up to the shack. I don't know what day that was. It was hard to try to keep track of everything. I got something to eat and slept that night, anyway.

"Almost all operation was on forty meters with one UV-203-A. After a few days of steady operation, two 'S' tubes went out due to continuous use and old age with a highly fluctuating line voltage at the time. It was then that the City of Barre sent a message to the Army Base in Boston asking to have the necessary tubes sent up by the next plane. That was the last heard about them. About November 10, the other 'S' tubes went out taking the 203-A and half of the secondary of the plate supply transformer with it. That put the transmitter off the air altogether. It still is.

"About a week later, storm warnings came out, the water began to rise again and the city officials got real nervous. They wanted to know if I could handle emergency messages for them in case of another flood. I would hate to repeat what I told them! But I started on a 201-A transmitter with 'B' batteries and got QSO other stations but the water did not come very high and the lines were not out so did not have to use it.

"My own car was ruined in the flood but we borrowed two others and managed to beg, borrow or steal enough gasoline to keep them going. They were on the run most all of the time delivering messages locally, there being no local phone service.

"I have no idea of the number of messages handled. I have part of those originated and relayed but we did not have time to make copies of those delivered. I wrote them out on any kind of paper handy and gave them to the two fellows driving the cars to deliver and that's the last I would see of them.

"There were approximately 3500 words of press and 396 messages originated and relayed. None of the press was sent on my account, all messages were signed by city officials or press reporters. The traffic total would probably run close to 600 or 700 messages if we had had time to copy them

100,000
MERSHON CONDENSERS

WERE shipped from our plant in the last season. Just ONE was returned on account of electrical defects. One—out of a hundred thousand!

Made in a leak proof copper receptacle, rugged, strongly built, very simple to handle and adjust to any circuit—the Amrad Mershon Condenser is virtually indespensible in the field of modern radio.

MERSHON CONDENSERS are found particularly well suited to power supply devices employing the 210 tube. THEY COST LESS than a paper-condenser block designed for 210 operation and are MUCH MORE EFFICIENT!

Self-healing in case of puncture due to high voltage, large capacity in a small space and an average life of 30 years under normal operating conditions are factors that you cannot afford to overlook.

New Low Prices

Let us send you a new and constructive booklet, just off the Press, on the Amrad Mershon Condenser, showing hook-ups and giving a wealth of information. Address Department 28. We will also send a special Engineering Bulletin, if you desire it.

THE AMRAD CORPORATION
Medford Hillside, Mass.

MERSHON CONDENSER

AMRAD

Makers of the Amrad Mershon Condenser

Finer Reception

with these complete

AmerTran Units!

The AmerTran ABC Hi-Power Box. List Price $102.50 east of the Rockies, complete with rectifying tube.

These are instruments that will appeal to the engineer or experimentor as the highest standards for comparative purposes. Quality reproduction—limited only by the perfection of the speaker—noiseless reliable power without the nuisance of batteries or chargers—are available with these companion units.

The A B C Hi-Power Box deliveries uniform, dependable power from the house-current—supplying sufficient voltage and current for Push-Pull 210 tubes and all other A C tubes required in a modern receiver. The complete unit contains AmerTran designed equipment with a power transformer having windings to provide current for all tubes.

With AC power supply or batteries, the tone fidelity brought by the AmerTran Push-Pull Power Amplifier is actually limited only by the perfection of the speaker. The energy output is increased especially at the lower musical frequencies bringing greater clarity at high or low volume. Furnished with cable and plug the amplifier connects directly with the ABC Hi-Power Box.

See these new AmerTran products on demonstration at any store displaying the sign "Authorized AmerTran Dealer" or, write direct to this Company. Both wired units are licensed under patents owned or controlled by R C A and must be sold complete with tubes.

The AmerTran Push-Pull Power Amplifier. List price $60, east of the Rockies. Price of Amplifier complete with tubes depends on tubes specified.

American Transformer Co.

174 Emmet St., Newark, N. J.

"Transformer Builders for Over 27 Years"

for the files. The 396 messages and press first mentioned would be found here on file any time needed.

"There was quite a variety of traffic. The majority was purely personal stuff but at the same time we ordered materials for the various city departments, ordered tank trucks and gasoline, gave dope on the roads to route trucks over, gave names and locations of communities where food and medical supplies were most needed, handled official messages for the governor, gave all the data on the flying fields in the vicinity, asked for and delivered instructions for show troupes, salesmen, etc.

"By the way, the dope on the airports was sent by the City of Barre to the Boston Army Base to be forwarded to all fields sending planes here. I met most of the pilots personally later and they said that they had received none of this information. That was rather too bad, seeing that a plane smashed in Montpelier, the passenger being killed and the pilot seriously injured.

"Have been pretty sick with the grippe lately so haven't had a chance to report sooner. The doctor says I will have to have my appendix out before long so don't know when I will be back on the air again. Hope this report gives you all the dope you wanted, OM.

G. E. Cruickshank, 1BDX."

Changing Wavelength

Gatun, Panama, C. Z.

Editor, *QST*:

I've been wanting to write for a long time concerning the reception of signals down here, and since reading an article about the unsteadiness of waves from broadcasting stations and that they were not keeping on their assigned frequencies, I have this to say.

I've been observing the signals from two stations in the twenty-meter band for quite some time. These stations, 2XAD of Schenectady and HJG of Bogota, Colombia, at 6.30 p.m. are right on top of each other but as evening draws along they become separated to the extent that HJG does not interfere with 2XAD. Some nights they are as much as 30 kilocycles apart at 9.00 p.m.

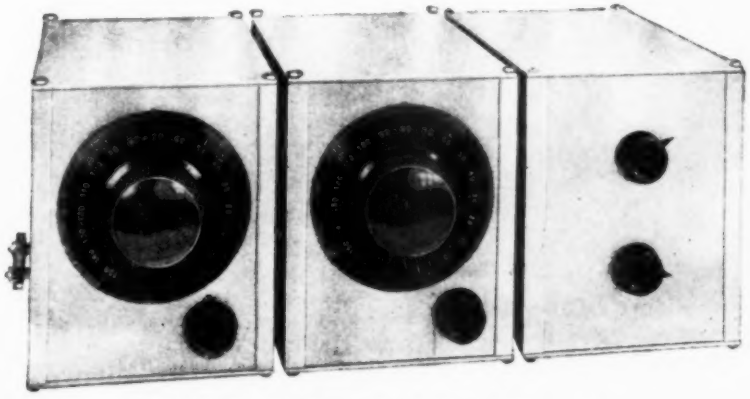
As I understand it, both stations are inland so that the rise and fall of the tide, presumably, could have nothing to do with it. I have tried to figure the meaning of this but am no closer to the answer than when I first noticed it. These stations, I believe, are both crystal controlled, so it doesn't seem possible that their waves are creeping.

I would like to have someone enlighten me on the subject as it has an effect on some work I am doing.

—*Henry P. Karr.*

ALUMINUM

The mark of Quality in Radio



The Q. S. T. (December) Short Wave Set

Improved reception is obtained in this excellent hook-up by the use of three standard Aluminum Box Shields

Now You Can Get

Greater Distance — Better Selectivity

BOTH advanced amateur set builders and professional designers recognize the advantages that result from Aluminum Shielding.

Aluminum Shielding gives *greater distance, better selectivity—closer tuning.* Its use eliminates or greatly reduces interference. **It is ideal for shielding circuits using the new shielded grid tubes.**

Aluminum Company of America's standard box shields, designed especially for amateur sets, are made of heavy Alcoa Aluminum with satin-dip finish, size 5 in. x 9 in. x 6 in. high. They are easily adapted to smaller sizes. They require no soldering.

The Q. S. T. Short Wave Set (described in the December issue of this magazine) employs three standard Aluminum Box Shields.

If your dealer cannot supply you with standard Aluminum Box Shields send us your order and we will have an authorized dealer ship promptly at $3.50 each. You simply pay the postman.

Write for free copy of the book, "Aluminum for Radio." It contains many helpful hints for amateurs.

ALUMINUM COMPANY OF AMERICA

2460 Oliver Building **Pittsburgh, Pa.**

ALUMINUM SHIELDING *for Improved Reception*

CONTROL! CONTROL!

CONTROL!

YOU fellows who work on short-wave transmission and reception know the value of precise control. No use telling you the value of micrometric resistance—adjusted to a hair, noiseless, reliable, stable, fool-proof—as found in the Clarostat.

If you want micrometric resistance control for the receiver, particularly razor-sharp regeneration, use the Volume Control Clarostat (practically zero to 500,000 ohm range, with 7-watt rating.)

If you want line-voltage compensation, use the Low Range 25-500 Power Clarostat. Other Power Clarostat ranges, ¼ to 10 ohms; 200 to 100,000 ohms; with 40-watt capacity.

If you want a variable grid leak for the transmitter, use the Universal Clarostat, or, for the smaller job, the Standard Clarostat (practically zero-5,000,000 ohm range, with 20-watt capacity.)

If you want power unit voltage control, use the Power Clarostat or the Standard Clarostat.

Write us for dope regarding Clarostats and how to use them. And when you buy Clarostats, be sure you get the genuine job in familiar green box and plainly stamped Clarostat on metal shell. Don't be fooled, O. M.

American Mechanical Laboratories, Inc.
Specialists in Variable Resistors
285 North 6th St. Brooklyn, N. Y.

MADE IN U.S.A.

An Interesting Letter

Oakmont, Pa.

Editor, *QST:*

Enclosed is a letter from a high school boy. It appears that it pays to help the youngsters, doesn't it? This fellow is a fine operator now and handles stuff like a commercial operator. He surely has made remarkable progress.

—*A. W. McAuly, 8CEO.*

411 Palmwood Ave.
Delta, Ohio.

Mr. A. W. McAuly, 8CEO
309 Third Street
Oakmont, Pa.

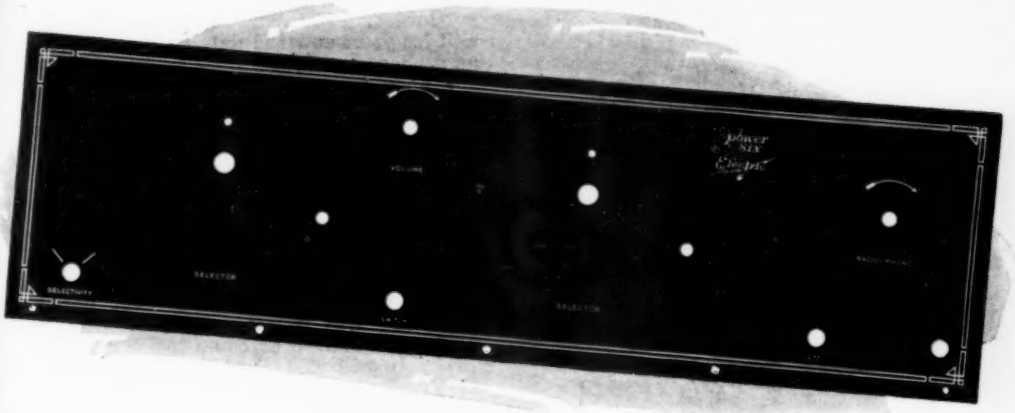
Dear OM,

Turn your mind back to a day along in January of this year and you will doubtless remember receiving a card from a fellow operating a station 8BNW, requesting a schedule with you. At that time I had been actually operating about four months and I was, to say the least, rather green. I picked your station because of the fine note, loud signals and especially on account of the fine steady operating and consistency of the station. I soon found that my faith was justified and no one was more pleased than I when you accepted my schedule.

Under your care and guidance, and with the comradeship which we have gained, I flatter myself that I have become more than just a lid operator. I hold a commercial license, am an ORS and have made a fair showing in traffic, and to you, OM, I owe a great part of my success. You were my first schedule and I have tried to live up to it, and I believe that we have been as nearly consistent as was humanly possible, under the circumstances, and right now I want to take this opportunity of thanking you for your help and consistency and to compliment you on the fine spirit of cooperation which you have shown in every way. Words cannot adequately express my kindly feelings toward you.

I have beside me a small yellow card stating that the credits of one F. C. Everett are satisfactory and that he will be permitted to register at the University of Michigan. I also have a letter stating that it will be necessary for all freshmen to be at Ann Arbor shortly. Need any more be said? I fear that our schedule will soon end and that I will light out for the tall buildings where men are students and girls are co-eds. I expect to take a receiver with me but no transmitter, for too much radio will bring too little study. I certainly have enjoyed our association and hope that we may continue to be the best of friends, with the hope of meeting you personally some day.

Our schedule will continue as usual until the time that I will leave. This will give you plenty of opportunity to obtain some station to take my place, possibly you and 9APY could make direct contact now that fall and winter is approaching. This is



Four New Kit Panels!

Bremer Tully Power Six Electric; Karas A-C Equamatic; Karas Knickerbocker Four and Tyrman "70" front and sub panels are recent additions to the Formica line. There are also available panels for battery sets of the same makes and the World's Record Ten; H. F. L. Nine-In-Line; Magnaformer front and sub panels; Madison-Moore; Melo-Heald; Camfield Nine and many others. :: ::

Special panels cut to any size and tubing, rods, etc. is also available for amateur use.

The Formica Insulation Company

4618 Spring Grove Avenue Cincinnati, Ohio

Any jobber or dealer can get Formica panels for you.

FORMICA

Formica has a Complete Insulating Service for Manufacturers.

ACME
Flexible
Celatsite Wire

A cable of fine, tinned copper wires with non-inflammable Celatsite insulation. Ideal for sub-panel or point-to-point wiring. Strips easily, solders readily. Nine beautiful colors; *sold only in 25 ft. coils, in cartons colored to match contents.*

Acme Celatsite Wire

Tinned copper bus bar hook-up wire with non-inflammable Celatiste insulation, in 9 beautiful colors. Strips easily, solders readily, won't crack at bends. Sizes 14, 16, 18, 19; 30' lengths.

Spaghetti Tubing

Oil, moisture, acid proof; highly dielectric —used by leading engineers. Nine colors, for wire sizes 12 to 18; 30' lengths. (We also make tinned bus bar, round and square, in 2 and 2½ ft. lengths.)

Stranded Enameled Antenna

Best outdoor antenna you can buy. 7 strands of enameled copper wire. Presents maximum surface for reception, resists corrosion; this greatly improves the signal. Outside diameters equal to sizes 14 and 16. (We also offer solid and stranded bare, and stranded tinned antenna.)

Loop Antenna Wire

60 strands of No. 38 bare copper wire for flexibility, 5 strands of No. 36 Phosphor bronze to prevent stretching. Green or brown silk covering; best loop wire possible to make.

Battery Cable

A rayon-covered cable of 5, 6, 7, 8 or 9 vari-colored Flexible Celatsite wires for connecting batteries or eliminator to set. Plainly tabbed; easy to connect. Gives set an orderly appearance.

Send for folder

THE ACME WIRE CO., Dept. S
New Haven, Conn.

ACME WIRE
MAKES BETTER RADIO

just a suggestion of course, as it is not my intention to intrude upon your ideas. I will let you know the date of my departure as soon as possible.

I hope to meet some amateurs in Ann Arbor and possibly to be second operator at one or more of their stations. Since I am only sixty miles away perhaps I will be able to operate 8BNW once in a while. If you ever hear an Ann Arbor station signing "FE" for a personal sign or if you hear 8BNW, give me a call if just for old time's sake, OM.

The latchstring is always out to you and your family and if you can ever possibly come this way please drop in and see me. If I get a chance to come to Pittsburgh, I probably will take the liberty of coming to Oakmont and looking you up. If at any time I can be of any assistance to you, do not hesitate to call on me and I will be delighted to accomodate you.

With best wishes and the hope that this will be merely farewell and not goodbye. Drop me a line and let me know how you're getting along, and I'll be glad to hear from you even if I'm too busy to answer. Very very 73, OM.

Sincerely,
—Frederick C. Everett, 8BNW.

Can't Afford QST

Canton, Mass.

Editor, *QST:*

I have your follow-up letter to me as a former subscriber. It is not my custom to consider any such communications as anything but fuel, but this one in point is so unusually well done that I do not treat it in the usual way. Instead, I will explain.

QST gave me data which I found to be of great assistance to me in some rather unscientific experimenting I did during a year of disability due to sickness. For this reason I shall always feel grateful to it and to you. Conditions have now quite changed and I can no longer afford to have *QST* about, tempting me to spend much needed time and energy as you know I should be tempted to spend it. So please don't send any copies.

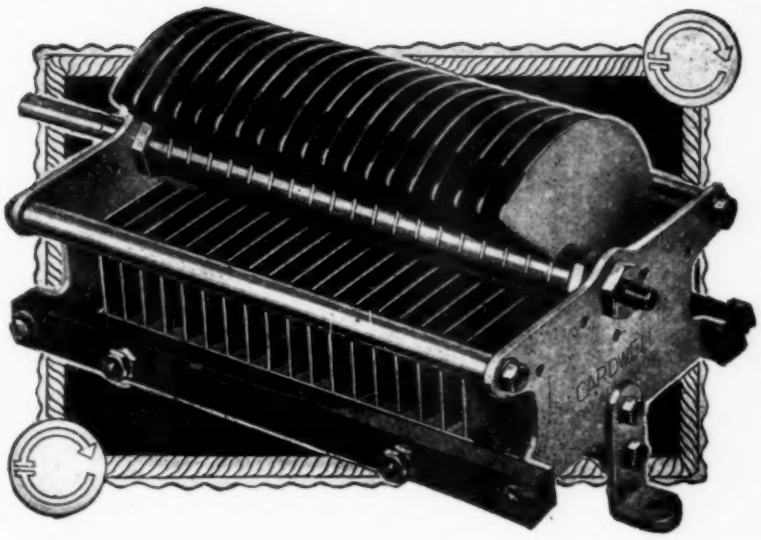
—James McKeen Lewis

QSLL and Keying

Red Lodge, Montana.

Editor, *QST:*

Say Gang, what is the matter with our QSL business? If we don't send more cards than we have in the past we will cause some of the printers to go out of business! We are falling down on the job when it comes to QSLing. I'll admit that I do not send a card first to every station worked and here's the reason why I don't. Last winter, I QSLed to every station worked and in nine times out of ten, I sent my card first. One day I sent thirty-four all at one shot. Well I didn't get thirty-



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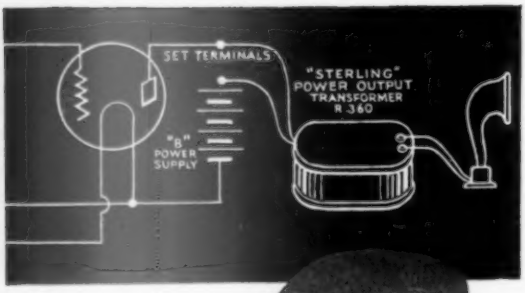

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make it more responsive to weak signals — IMPROVE TONE QUALITY — eliminate tube noises.

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This transformer is more than a protective device—it permits closer adustment of speaker diaphragm increasing its sensibility to weak signals—prevents shocks when using headphones—eliminates tube noises and IMPROVES TONE QUALITY OF THE SPEAKER. Attach in two minutes, leave permanently connected. Price $5.00.

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R-415
$8.50

THE STERLING MFG. COMPANY

2831 Prospect Ave., Cleveland, Ohio

four in return for those I sent. No, I'll admit I didn't. I received only four cards in return.

I didn't think of it so much at the time but after I began keeping close tab on the affair, I decided never to QSL first again, unless someone asked me to first and then they would send theirs after. Well, I tried this and still they would not send cards so I decided to try another one. Now, I do not QSL first under any condition, but the fellow who QSLs to me will certainly get one of my cards in return for his.

Of course, if all the gang were to try this same idea, we might just as well throw our cards away because there would never be any exchanging. But what I do want to see more of is that if a fellow asks you to QSL first by all means do so and to the fellow who asks the other chap to QSL first, be sure to send him one of *your* cards in return. If you do not want to send one of your cards, for Heavens sake, don't ask anyone to send you one of theirs! So much for that and now a few words about keying.

I have always been fond of a good steady note that seems to float in, that is, minus all sputters, gurgles and thuds usually caused by keying. My transmitters had steady waves but their notes were not the best on the air. I tried various ideas to kill those thuds but very few helped even a little bit.

The following diagram shows the arrangement I last rigged up, which to my surprise was the thing I had tried so long to get. My transmitter then sounded much like a MO-PA set and the signals started and stopped without the slightest sputter, gurgle or thud. This arrangement has proven very satisfactory here.

With it, a steady back wave will be emitted right on the main wave but much weaker than the main wave. It will not cause any QRM for the receiving operator. With the grid leak as shown, there is a small current passing all the time. In this case, there is not immediate starting and stopping of the signals or oscillations of the set when keyed and the effect will be "feathery". Your signals will "float" in now.

—O. W. Viers, 7AAT-7QT.

Strays

Jim Lamb, nu3CEI, ex-nu9CEI, who has been on an extended visit to Hq. tells us that wood for transmitting frames and for spreaders on two-wire feed lines may be obtained in most job printing plants and printer's supply houses. Strips of straight-grained cherry that have been seasoned, impregnated with vegetable oil and pressed may be obtained in various widths of from ¼ to 1½ inches. All are ⅝ inches thick. They are called printers "furniture", come in three foot lengths costing from eight cents per length, up.

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Confidence in a Name

Thirteen years of concentrated effort on a single product has brought such uniform perfection that confidence in these tubes and the name they bear is almost universal among radio enthusiasts.

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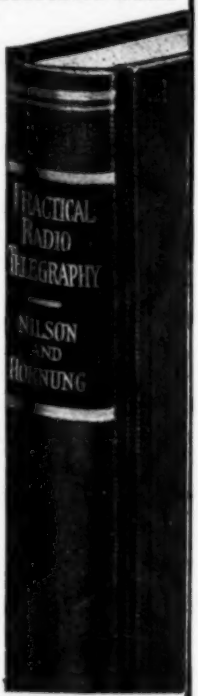

A practical book that should enable anyone of average intelligence to pass the Government's theoretical examination given to applicants for a Commercial Radio Operator's License.

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Quickly puts 25 per Hams in 35-40 per class. Five Hams report made this gain in few evenings. One of them by 75 minutes total practice only.

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C. K. DODGE, MAMARONECK, NEW YORK.

The Design of Variable Condensers for High-Voltage Operation

(Continued from Page 51)

condenser is supposedly not a conductor, but it must always be remembered there are always a few free electrons in any class of material, and that there is no such thing as a perfect insulator. We naturally select the best possible insulator, but it remains quite important to keep its mass and its contact with the high potential electrode of the condenser at a minimum.

Another important requirement for the insulation is that it be totally non-hydroscopic—that is, that neither its surface nor its interiors shall be in any way porous or subject to the collection of moisture. The surface should be very hard and smooth so that the least possible amount of dust will collect, because even dry dust will allow a large amount of leakage, and if it becomes at all moist the creeping of the electric current along the surface will cause a serious loss in efficiency. Protracted continuance of this creeping will eventually roughen the surface of the insulation, due to its heating action, after which it will be even more conductive than before, even when dry.

As we increase the voltage across the terminals of the condenser we must increase the thickness of the plates, not because of our need for a greater area of conducting material but because we have greater pressure at whatever corners remain and the radii of the curves composing these corners must be correspondingly increased in order to keep the density of charge sufficiently low. This will eventually result in a construction similar to Figure 2, and if we go even further we will find ourselves with a row of opposed spheres as in Fig. 3. This

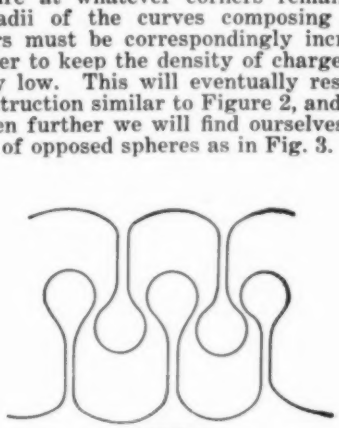

FIGURE 3

last construction, of course, is impracticable, because the capacity for any given amount of metal becomes extremely small, but it is interesting as an example of the construction that might be required if our voltage were to run, for example, over a hundred thousand. Such potentials in so-called air dielectric variable condensers are as yet not encountered, but when at any time condensers for such purposes become necessary, engineers will undoubtedly find a method of producing them more economically than at present.

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[*Completely Shielded*]

T-2180—Secondary: 5 volts, center-tapped. Capacity: 15 V.A. Dimensions: 3⅜"x2¼"x3¼" high. Weight, 2½ lbs. Price **$5.00**

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T-2504—Secondary: 3 volts, center-tapped. Capacity: 35 V.A. Dimensions: 3½"x3"x3¾" high. Weight, 3½ lbs. Price **$7.50**

T-2445—Secondary No. 1: 1.5 volts, no center tap, 12 V.A. Secondary No. 2: 2.65 volts, center-tapped, 10 V.A. Secondary No. 3: 5 volts, center-tapped, 5 V.A. Dimensions: 2¾"x5¾"x4¾" high. Weight, 5½ lbs. Price **$10.00**

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[*Steel Case, Crackle Finished, Compound Filled*]

T-2385—Secondary: 550 V. and 750 V. each side of center tap. Capacity: 100 V.A. Dimensions: 5"x5¼"x6" high. Weight, 8½ lbs. Price **$16.00**

T-2387—Secondary: 1000 V. and 1500 V. each side of center tap. Capacity: 300 V.A. Dimensions: 7½"x5¾"x7½" high. Weight, 20 lbs. Price **$22.00**

T-2388—Secondary: 1500 V. and 2000 V. each side of center tap. Capacity: 500 V.A. Dimensions: 7½"x6⅛"x8½" high. Weight, 27 lbs. Price **$30.00**

T-2389—Secondary: 1500 V. and 2000 V. each side of center tap. Capacity: 1000 V.A. Dimensions: 7½"x7"x9½" high. Weight, 40 lbs. Price **$40.00**

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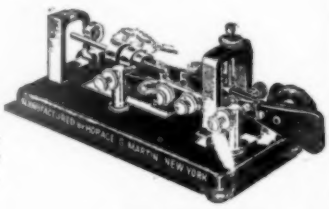

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The illustrations show a number of interesting examples of variable condensers built for high powered installations such as are now being used in broadcasting and high powered commercial stations or trans-oceanic telephony. One of the largest variable condensers ever built has a voltage breakdown of over 15,000 r.m.s. and a capacity of 800 picofarads. It is nearly 30" long and weighs over a hundred pounds, although built chiefly of aluminum. Each condenser is usually built for its own special job and no attempt has been made to standardize at the present time on models for breakdowns very much above ten thousand volts r.m.s., although they have been manufactured for r.m.s. voltages above fifty thousand.

Experimenters Section

(Continued from Page 53)

with a large condenser across the terminals gives an almost pure d.c. note. A second person to work the key (or crank) is a convenience but not necessary. Incidentally, the weight of this power supply is 25 lbs.

The set as shown has done good work at 80 and 40 meters but not at 20 meters. On using a "growler" tone tester I found that variations in speed on the generator "prime mover" caused variations in voltage of such proportions as to cause "yoop yooping" in the wavelength. Using the set in the station but with B batteries on the plate, this was absent and one can do very nicely on 20 meters.

B batteries undoubtedly would be the ideal plate supply on any wave but take up too much room and in my particular case are not as economical as the "Megger" which cost only $8.50.

Just one thing more. The "flashlight-bulb-in-the-antenna" has been *thoroughly unsatisfactory* and has been replaced by a 0-25 milliammeter in the grid-leak circuit. This indicates resonance very definitely.

BARCLAY CHARTS

We have a few Barclay charts at present. Anyone desirous of one of these handy charts may have one by writing the Experimenters' Section.

—*R. S. K.*

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SUPERIOR CONDENSERS

FLECHTHEIM superior condensers are best for amateur and experimental use. List less 35%. Send for folder.

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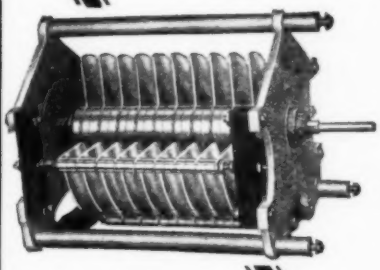
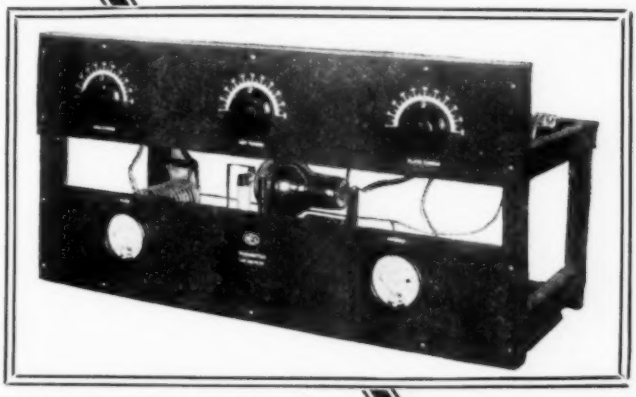


REL transmitting kits are known the world over. Amateurs everywhere are enjoying REL power and efficiency. REL has become the symbol for mechanical perfection wherever Short Wave enthusiasts gather.



THE Tuned Plate Tuned Grid (pictured) equipped with the new REL Super Condensers as well as the universally known Transmitting Inductances, is one of the best buys in Radio today! This kit has proven to be one of the most popular known.

LOOSE COUPLED HARTLEY

7.5 watt kit	$56.00
65 watt kit	63.00

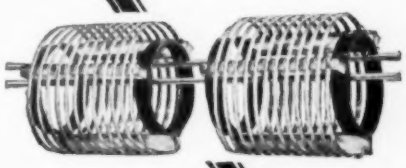
TUNED PLATE TUNED GRID

7.5 watt kit	$71.00
65 watt kit	80.00

M. O. P. A.

7.5 watt kit	$86.00
65 watt kit	96.00

Prices of larger kits given upon application.



SEND 25c (no stamps) for REL's Short Wave Handbook. It's one of the most comprehensive collections of S. W. data that can be found. It will earn a prominent place next to the "heap". Kept up to date by the timely issuance of data sheets, mailed to you free, of course.

REL owns and operates experimental Station NU2XV on 15.1. 30.2, and 60.4 meters

Radio Engineering Laboratories

REL **100 Wilbur Avenue, Long Island City, N. Y.** REL

(Continued from Page 38)

out in case of a short circuit. Next in line are the two carbon pile rheostats which are in the primary circuits of the filament transformers, and last is a switch in the 110-volt line. In addition to the r.f. chokes being behind the board, the battery charger and starting switch are also there. The starting switch is controlled by a long lever which can be seen to the left of the board. The whole power apparatus is on the opposite side of the room from the transmitter and receiver. This was done to prevent any a.c. hum in the receiver.

The antenna system is suspended between two fifty-foot poles which are supported by guy wires that are broken every eight feet with insulators. The antenna and counterpoise are made of number twelve enameled copper wire and are insulated with Pyrex. The antenna portion of the system is an inverted "L" affair, eighty-six feet long and fifty feet high. The counterpoise portion is eighty-four feet long and eight feet high. It is operated at its third harmonic for 39.5 meter transmission.

The wavemeter and Grebe CR-18 receiver can be seen in the large photo. To the right on the wall can be seen the starting lever which operates the switch which is behind the switchboard on the opposite side of the room. The little switchboard behind the receiver controls all batteries and above it can be seen the loud speaker.

The Southeastern Division Convention

(Florida Division)

MIAMI was certainly the Mecca for the "hams" on January 13th and 14th. The Hotel Alcazar saw the registration of A.R.R.L. members and amateurs from every section of Florida besides representatives from the first, third and sixth districts. President R. B. Ladd of the Miami Amateur Radio Club, under whose auspices the convention was held, received the delegates with his bright smile and was ably assisted by E. E. Young, Secretary, who seemed to be the "jack of all trades" of the club. Quite out of the ordinary, there were no set technical meetings but plenty of "talks" by everybody. One of the interesting trips was to WAX, the Tropical Radio Co's commercial station where the delegates received a cordial reception and were given an opportunity to inspect the big tube transmitters. The one of most interest was the 20-Kw. water-cooled tube outfit working near our 20-meter band. Another good trip to show the other angle of radio was to radio broadcast station WIOD where we found an old-timer in

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Radio Power Units

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The leading radio of today

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The Crosley Bandbox is now supplied in two models—the 602 in which the power department is separate from the receiver and the 704 in which it is housed in the same case for $95. The two models are identical—there being no difference in the amazing performance which so definitely marks the Bandbox 1928 greatest radio.
A genuine Neutrodyne! A high degree of sensitivity! Amazing selectivity! Compare the Bandbox with any set. Convince yourself of its superiority, visit your nearest dealer and hear its wonderful performance. Write Dept. 18 for descriptive literature.

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EVERY TRANSMITTING AMATEUR USES THESE FORMS

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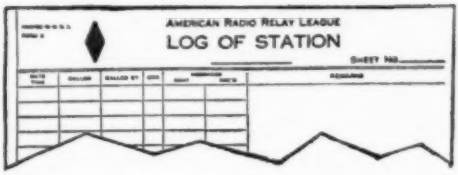

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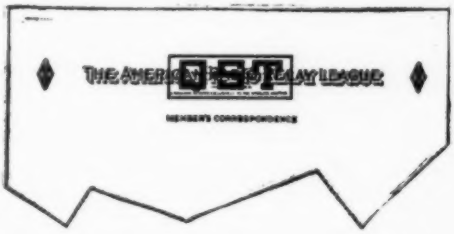

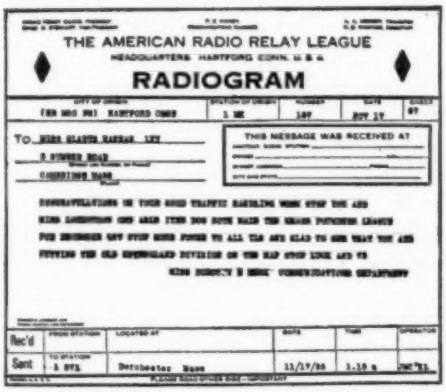

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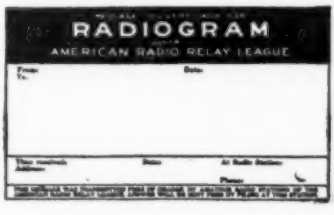

American Radio Relay League

1711 Park Street **Hartford, Conn.**

PRECISION!

Sangamo engineering of Audio Apparatus is followed up by precision production methods gained in nearly 30 years' precision instrument manufacturing. In Sangamo Transformers and Impedances the set builder and manufacturer is thus assured of that precise matching of each unit to the designated tube so necessary for superior tone quality.

The "Yellow Spot"
Designates the Sangamo Type "A" Audio Transformer used for cascade amplification. This transformer has the flattest curve (most uniform amplification at all audible frequencies) available in any transformer at the present time. Look for the transformer with the yellow spot.

"Dark Blue"
The Dark Blue Spot identifies the Sangamo In-put Transformer for push-pull amplification. Has high inductance primary to secure high amplification on low frequencies. Accurately divided secondary gives almost identical frequency characteristic curve on each half. "Type B"—known by the dark-blue spot.

"Light Blue"
Output Transformer for push-pull amplifier having an impedance to match UX-210, CX-310 and UX-112, CX-112 tubes. Maximum transference of energy on low end of the musical scale.

"Green"
Same as above except impedance matches UX-171 and CX-371 tubes.

"Red"
The Red Spot designates the Sangamo Type "E" Output Impedance, keeps heavy D. C. "B" current from loudspeaker windings. Tap provided for matching impedance to UX-171 (CX-371) or UX-210 (CX-310) tubes, also UX-112 (CX-112).

"Orange"
Used for impedance coupled amplification, auto-transformer coupled amplification, or as impedance in plate circuit of detector tube to prevent feedback, oscillation or "motor-boating" in transformer coupled amplifier.

Also makers of Sangamo Mica Condensers, moulded in Bakelite—made accurate and **stay** accurate.

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SPRINGFIELD, MASS.

QUALITY DONGAN PRODUCTS

--at Slight Cost
--in a Few Moments
Your Set Can be AC Operated

There is a Dongan A C Transformer designed specifically for each of the approved A C Tubes.

for instance here is No. 6512

A remarkably well-designed and sturdy A C Transformer, mounted in a crystalized laquered case, equipped with lamp cord and plug outlet for B-Eliminator, also tap for control switch. Operated with 4 UX226, 1 UY 227 and 1 UX 171 R C A Tubes $5.75 list.

Then you can have exactly the same transformer without plug outlet and control switch tap—No. 6515 for **$4.75 list.**

Ranging in price from **$3.50 to $5.25,** there are 10 other A C Transformers, operating with the approved A C Tubes.

Send check or money order if your dealer cannot supply you.

Custom Set Builders-Write for our special proposition to Custom Set Manufacturers.

Dongan Electric Manufacturing Co.
2999-3001 Franklin St., Detroit, Mich.

TRANSFORMERS of MERIT for FIFTEEN YEARS

Jesse Jay, chief engineer, formerly of the ninth district. Needless to say, we were well received. The Chamber of Commerce, through the courtesy of its secretary, allowed the use of the reception hall where we had a chance to see the moving picture film of A.R.R.L. headquarters and a two-reel affair, "Awakening of Rip Van Winkle", the latter kindly furnished by the Radio Corporation of America. Director Dobbs being unable to come sent Henry L. Reid, SCM for Georgia, to represent him and Henry certainly did a good job with his talk at the traffic meeting. He proved himself a most entertaining toastmaster at the Banquet. Treasurer Hebert of the A.R.R.L. got his inning during the banquet and enlightened the gathering with details of the International Radiotelegraphic Conference and ended his speech with one of his inspirational talks.

The distribution of prizes as the last event of the program has proved a very good custom. It results in the fellows' staying over until the very last, and with the generosity of the League's advertising friends makes it worthwhile. The fellows who are fortunate enough to win a prize should never forget to write the donor and express their appreciation.

With a visit to the prominent ham stations till the wee hours, this, the first Florida convention, closed with everybody expressing their thanks to 4CK, 4NM, 4NZ and 4OP.

—A. A. H.

I. A. R. U. News

(Continued from Page 54)

20-meter band has not been very good. Our famous ten-watt DX getter, eg5YX, has been getting over pretty well but there has been no one to work! 2CS worked several NU stations on 23 meters with an input of only two watts.

"Christmas day was wonderful for 40-meter DX and the sixes came rolling in in a bunch with fives and nines up to 1000 G.C.T. Since then, things have been as dead as possible but woke up a bit after about a week. Does anyone besides nu1SZ and nu1AWE operate on week days?"

—K. E. Brian Jay, eg2HJ.

IRISH FREE STATE

"There are now 20 stations licensed in the Free State for a maximum power of ten watts and transmission on the 45-meter band. About five of these stations also use the 23-meter band. A number of these have been rather inactive of late.

"The most active stations and those obtaining the greatest success at the end of 1927 are 12B, the station of the Wireless Society of Ireland, 18B and 17C who are in

32 Pages Bigger!

THE new edition of the RADIO AMATEUR'S HANDBOOK has 32 pages more than the last edition. That's because additional information has been inserted in all parts of the book and everything has been brought right up to date. Two hundred and sixty-six pages of dope, data and details—all for one dollar, postpaid anywhere.

OF course you can struggle along with the old edition—or it's even possible that you can do without the Handbook entirely—but why handicap yourself when it costs only a dollar to have the new Handbook in reach whenever you need some radio information?

This is easier than writing a letter →

AMERICAN RADIO RELAY LEAGUE,
Hartford, Conn.

Here's my dollar—you know what I want.

Name.....

Address.....

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NEW!

Transmitting Apparatus at New Low Prices

REL 20 & 40 meter or 40-80 meter transmitting inductance (two coils, rods and clips) . $8.85

NEW THORDARSON TRANSFORMERS
7½ volt filament transformer for UX 210s . $6.10
12 volt filament transf'm'r for UV 203A and UX 852 $7.95
100 watt plate transformer, 550 and 750 volts, either side of center tap . $14.35
500 watt plate transformer, 1500 and 2000 volts, either side of center tap, special for UX 852 tube $25.75

JEWELL 3 in. flush mounting AC and DC voltmeters, scale readings up to 80 volts . $5.95
D. C. milliammeters, any scale reading . $5.95
Antenna thermo-ammeters, any scale reading . $9.75

CARDWELL NEW TYPE-TRANSMIT'G CONDENSERS
Type T 183, 6000 volt .0015 MFD
Type T 199, 3000 volt .0037 MFD $8.95
Type 147 B, 3000 volt .0045 MFD
Type 164 B, 3000 volt .0025 MFD 6.45

GRID LEAKS Large General Electric 5000 ohm . $1.45
" Ward-Leonard Cent. tap 5000 ohm 2.45
" Ward-Leonard Cent. tap 15000 ohm 5.45
Ward-Leonard 5000 ohm Cent. tap 1.80
Crescent Lavite special 5000 ohm leak 2.25
Allen Bradley variable transmitting leak 2.95

FIXED CONDENSERS

SANGAMO Large .002 mfd. 500 volt . . $ .50
Condensers .002 mfd., 5000 volt 1.75
DUBILIER .002; 6000 volt 1.95
FLECHTHEIM 2mfd 1000 volt, test 800, working 2.75
Guaranteed 4mfd 1000 volt " " " 4.75
Filter 1mfd 2000 volt, test 1500, working 2.75
Condensers 2mfd 2000 volt " " " 4.85
4mfd 2000 volt " " " 6.95

(Flechtheim filter condensers are guaranteed against break down. Blown condensers will be promptly replaced without charge.)
PYREX STANDARD SOCKETS *For 202s, 210s, etc. 65c

RADIO 2MA CO.
168 Washington St., New York

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JUST OUT!

March Number

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$1.00 Each

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ONE YEAR

(3 Issues)

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(Foreign $2.75)

Amateur and Commercial Stations From 80 Countries

Citizens Radio Service Bureau

Room 751, 508 So. Dearborn St., Chicago, U. S. A.

Dublin and a newcomer, 11D located in Naas, County Kildare.

"During the past few months, 12B has been engaged in making observations on the 'skip effect' on the 45-meter band. Some test work on 23 meters has also been done and it is hoped that regular transmission on that wave will be made in the early part of the new year.

"17C has been doing some fine telephone work on 45 meters and has been able to work Canada recently. He continues to keep up his good work on the 23-meter band and in addition to raising many NU stations was the first to work a Brazilian station. He

THE ABOVE IS A VIEW OF eg5ML

The panel to the left of the one holding the tubes, is the crystal oscillator which couples into the main transmitter for 45-meter work. The antenna system is of the current feed Hertz variety and keying is done in the feed line. A 100-ohm resistor is placed across the key to eliminate clicks. Underneath the table are accumulators for filaments and grid bias for the crystal transmitter. Main supply of high voltage comes from a motor-generator set.

uses the 220-volt d.c. house mains for plate supply. A fairly long inverted "L" antenna makes up the radiating system.

"Reports on signals from any GW stations will be welcomed and with QSL cards should be addressed to Wireless Society of Ireland, 12 Trinity Street, Dublin, C.I., Irish Free State."

—H. Hadgens, Hon. Sec., Wireless Society of Ireland.

NORTHERN IRELAND

The last few months seem to have been a period of comparative inactivity among transmitters in Northern Ireland. There has been little startling DX achieved if, indeed, any DX is now considered startling, and many stations report conditions exceptionally poor. It has been suggested that this may have some connection with the fact that the sun spots are at present at their maximum. It is understood that these sun spots perform a complete cycle in 11 years, i.e., they would have been at a minimum seven and a half years ago. The writer and several others are inclined to

THE AMATEUR'S BOOKSHELF

Readers of *QST* appreciate the need for good radio books. What we consider to be the best standard text books are handled by A. R. R. L. Headquarters for the convenience of members of the League and readers of *QST*. Those listed below pretty well cover the requirements of the average amateur or experimenter.

Radio Telephony For Amateurs, by Stuart Ballantine. The most valuable single book that we know of for the amateur. Theory, construction, practice. Not particularly about telephony. Heartily recommended for every amateur. 296 pp., 5½ x 8¼ $2.00

Manual of Radio Telegraphy and Telephony, by Commander (now Admiral) S. S. Robison, U. S. N., published by the Naval Institute. "Ranks with the very best of all published radio matter . . . Not only worth its cost but is perhaps the best radio book that ever came to this desk."—*QST* Book Review. 895 pp., 6¾ x 10 ..... 5.50

Experimental Radio, by Prof. R. R. Ramsey. Revised Edition. The book for the experimenter. A laboratory manual, describing 85 excellent experiments that help in understanding radio work 2.75

Principles of Radio Communication, by Prof. J. H. Morecroft. An elaborate general textbook. 935 pp., 5¾ x 9 ..... 7.50

Radio Engineering Principles, by Lauer & Brown. An excellent general textbook 3.50

Thermionic Vacuum Tube, by H. J. Van der Bijl 5.00

Radio Frequency Measurements, by Moulin 10.00

Practical Radio Telegraphy, by Nilson & Hornung 3.00

Prepared Radio Measurements, by R. R. Batcher 2.00

Elements of Radio Communication, by Ellery W. Stone 3.00

Wireless Pictures and Television, by T. Thorne Baker 2.50

Radio Questions and Answers, on Government Examination for Operators, by A. R. Nilson 1.00

How to Pass The U. S. Government Wireless Examination, by E. E. Bucher ..... .60

Radio Simplified, by Kendall & Koehler, revised by J. M. Clayton 1.00

Ideas For The Radio Experimenter's Laboratory, by M. B. Sleeper ... .25

Henley's 222 Radio Circuit Designs, by Anderson, Lewis and Mills ... 1.00

Henley's Workable Receivers, by Anderson and Lewis 1.00

Prices include postage

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For automatically switching on and off your B Eliminator and Charger, or either, and in addition, automatically **switching off your Charger when the battery is fully charged.** With the Full Automatic Voltage Relay it is now practical to utilize the advantages of a high rate charger and at the same time control the switching of the charger as well as the B eliminator with the switch or filament control on the set.

NO. 440.....$7.50

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Harfield Resistors are available in various capacities up to 50,000 ohms at 10 or 20 watts. Tell us about the resistor you want, and let us make a sample for you with prices. *Write to*

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RESISTORS

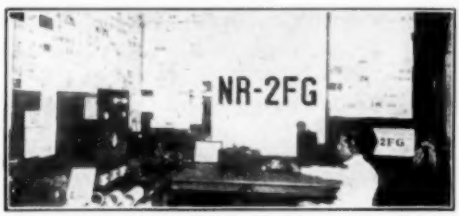
FACTORY
215 Emmett St.
Newark, N. J.

think that there has been a steady fallin, off in DX conditions during the past few years (making due allowance for the greatly improved apparatus, new wavebands exploited, et cetera). There seems to be an opportunity for some coöperative observation by amateurs throughout the world during the next few years and a possibility of reaching some interesting conclusions.

"A report from 6YW is to the effect that NU signals are often good on the 80-meter band on nights when they are poor on the 40-meter band. Why not try some more transatlantic work on 80 meters?"
—*E. Megaw, Area Manager for Northern Ireland, R. S. G. B.*

ITALY

Mr. Franco Pugliese, secretary to the Italian I. A. R. U. Section, returned to Italy in November after traveling to Capetown with a scientific expedition which left Italy in April, 1927. He is the owner and



IN SAN JOSE, COSTA RICA MAY BE FOUND nr2FG, THE STATION VIEWED ABOVE

A pair of 203-A tubes are used in a T.P.T.G. circuit for 34-meter work. For 20 meters, either a 203-A or 852 is used. Plate supply is obtained from a 1,000-volt motor-generator set and filaments are heated from two 120-ampere hour storage batteries. Two masts that are 74 feet high and 110 feet apart support the ninety foot single wire inverted "L" antenna used against a ninety foot counterpoise for transmission. A separate antenna is used for receiving. The present receiver is a Grebe CR-18.

operator of the short-wave equipment which worked many amateurs under the call of xei1FP.

The object of carrying radio equipment was to study, in connection with military and amateur stations, the propagation of waves between fifty and fifteen meters at both short and great distances.

The main transmitter was a two-hundred watt affair which was supplied from the 600-cycle ship's generator. In addition to this, a portable transmitter using a single UX-210 fed with 200 volts from batteries was carried along. A "Bourne" two-valve receiver and a short-wave superheterodyne comprised the receiving equipment. The antenna was a single wire 22.5 meters long, which though entirely screened by the metallic surroundings of the ship, gave excellent results both in reception and transmission.

Regular contacts were established on 33 meters with African and American stations at distances greater than 11,000 kilo-

MORE SPECIAL OFFERS

UNI-RECTRON POWER AMPLIFIERS

MODEL AP-935

AS the Uni-Rectron stands it is a super power amplifier, which can be used in connection with any radio set and loud speaker. Binding posts are provided for input to the Uni-Rectron and output to the speaker. Requires no batteries for its operation. It obtains its power from the 110 Volt, 60 Cycle alternating current lighting circuit of your house.

The UX-210 super power amplifying tube and the UX-216B or 281 rectifying tube are used with this amplifier, which cannot overload. From the faintest whisper to the loudest crash of sound—R.C.A. Uni-Rectron amplifies each note at its true value. High and low notes are all treated alike.

The volume and quality delivered will be a revelation.

Also by removing the input and output transformers it can be used as a source of power for an oscillating or transmitting tube, furnishing power for all circuits, grid, plate and filament and is the cheapest form of Power Supply for Amateur Transmitting purposes ever offered.

LIST PRICE $88.50
(Without Tubes)

SPECIAL at $19.75 EA.

KENOTRON RECTIFYING TUBES

(TYPE T. B. 1) **MFD. BY GENERAL ELEC. CO.**

These rectifying tubes operate on a filament voltage from 8 to 10 Volts and draw 1½ amps. They will safely stand an A.C. input voltage up to 750 Volts and pass plenty of current and voltage for the plate of the Transmitting Tubes.

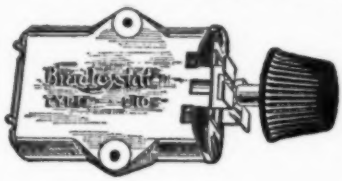
They are also very efficient rectifiers for use in "B" Battery Eliminators.

STANDARD BASE
NEW IN ORIGINAL CARTONS

PRICE ONLY $1.25 EA.

TYPE E-210 BRADLEYSTATS

MFD. BY ALLEN-BRADLEY CO.



Bradleystat E 210 is a compact graphite disc rheostat well suited for filament and plate control applications.

By using it in the primary circuit of the Transformer the center tap is not displaced and the Transmitter efficiency is greatly improved.

One knob provides noiseless, stepless control.

Can also be used to control output of Eliminators or Power Packs. NEW.

LIST $4.00

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QUARTZ CRYSTALS
Prepared for Maximum Piezoelectric Effect

One inch sections ground to within 1% of your specified frequency:

75-100 meters	$17.50
100-200 meters	10.00
200-500 meters	15.00
Blanks, 2 to 3 m.m. thickness	7.50

All sections guaranteed free from flaws or twinning and tested for oscillation without regeneration.
Quotations on request for crystals of any practicable specifications.

J. T. ROONEY, B. Sc., 31 CALUMET BUILDING, BUFFALO, N. Y.
"Ten years of crystallographic experience"

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Patented Sept. 8, 1925; Sept. 7, 1926
Made in Both 5 in. and 7 in. diameters
For Erecting 4, 6 or 8 Wire Cage Antenna or Counterpoise
In active use at 58 U. S. and 7 Foreign Broadcasting Stations; also many ham stations. Price $6.00 per dozen; $3.25 for a half dozen.
Descriptive circular upon request.

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GET this improved "Sync" Rectifier. Superiority proven by its prevailing use in international transmitting. Lower in price in spite of higher quality.

The Advance Sync Rectifier meets all requirements for heaviest duty. Improves all transmission—giving clearer tone and better volume. Can be easily and quickly filtered. Speedy starting. Requires no attention—always ready. With ¼ H.P. Westinghouse motor, $55.00 complete.

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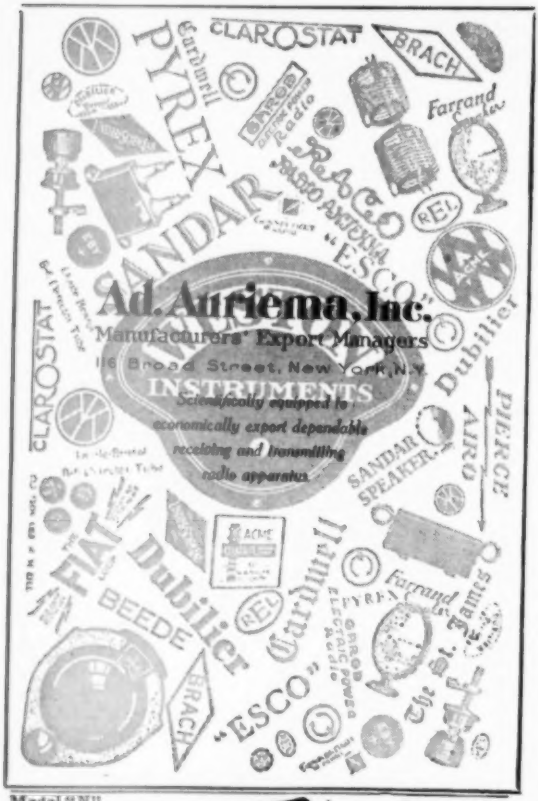

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Tune quickly—adjust accurately—eliminate distracting noises—get correct tube oscillation—with X-L VARIO DENSERS in your circuit.
Designers of all latest and best circuits specify and endorse.

MODEL "N"—Micrometer adjustment easily made, assures exact oscillation control in all tuned radio frequency circuits, Neutrodyne, Roberts 2-tube, Browning-Drake, Silver's Knockout. Capacity range 1.8 to 20 Mfd. **Price $1.00.**

MODEL "G"—Obtains the proper grid capacity on Cockaday circuits, filter and intermediate frequency tuning in super-heterodyne and positive grid bias in all sets. Capacity range, Model G-1 .00002 to .0001 Mfd. Model G-5 .0001 to .0005 Mfd. Model G-10 .0003 to .001 Mfd. **Price each with grid clips $1.50.**

X-L PUSH POST—NEW! Bakelite Insulated. Push it down with your thumb, insert wire, remove pressure, wire is firmly held. Vibrations will not loosen, releases instantly. **Price each 15c.**

Also in strips of 7 on black panel marked in white. **Price $1.50.**

FREE New up-to-date book of wiring diagrams showing use of X-L units in the new LOFTIN-WHITE constant coupled radio frequency circuit, and in other popular hook-ups, also the Goodwin Aperiodic Detector Circuit, applicable to any set; adds a stage without added tuning controls. Write today.

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meters (6,875 miles), although difficulty was experienced in working Europeans at great distances. It was found that the 44-meter wave used by most of the Europeans didn't cover distances greater than 4,000 kilometers (2,500 miles) when transmission was in a north-south direction.

No noticeable change in signal strength was observed on WIZ (43.02 meters) and U.S.A. amateur stations. In general, all signals between 30 and 40 meters coming from the west were received with approximately the same signal strength when we were on either the eastern or western coast of Africa.

It was noticed that the signals from WIZ and IDO and others working on waves between 30 and 40 meters faded away completely when daylight appeared while PCRR, FY and others around 20 meters were readable at nearly all hours though considerable fading occurred during daylight. The position of the station did not seem to effect the signal strength on 20 meters, European stations being received as well as WIK and ANF (Java).

A splendid time was had in visiting the South African amateurs, among which are to be found many excellent stations, a good amateur organization and plenty of real "ham" spirit. It was quite surprising to hear 6th district U.S.A. stations in the early afternoon as it is very difficult to hear them even at night in Italy. On the other hand, it was considered quite a record to receive the Zedders which may be worked rather easily from Italy.

A large number of stations in South and North America, Alfrica and Europe were worked with both transmitters. The smaller set proved to be nearly as effective for DX as was the 200-watt set.

Short-wave radio once more proved its great advantages and when used on ships sailing for distant countries, offers a possibility of obtaining news from the home port each day and, what is more important, an opportunity of comparing the ship's clock with the standard time. This is a very important point particularly in places where the long-wave stations cannot be heard. There are, no doubt, many problems still to be solved. Chief among these is the avoiding of interference caused by ventilators and other motor driven devices commonly found on ships and which often render reception of short-wave signals impossible.

WAC

We would like to point out once more that even if you have worked all continents, you are not a member of the WAC Club until you have a certificate of membership. We have recently seen some QSL cards indicating a certain station to be a member but have failed to find that particular call on the list. We are assuming this to have been done through ignorance and trust that this mention will be all that is necessary to clear up the matter.

VITROHM Transmitting Grid Leaks and Rheostats now cover the entire line of transmitting tube circuits. ¶The prices on these amateur products are reduced materially. ¶Your dealer should stock Vitrohm Transmitting Products. ¶If you have difficulty in obtaining them, write us direct.

CATALOGUE NUMBER	PRODUCT	RESISTANCE	DISSIPATION	CURRENT	MAX. TUBE RATING	PRICE
07-2	Grid Leak*	5000 ohms	44 watts	90 m.a.	100 watts	$2.00
07-3	Grid Leak*	5000 ohms	200 watts	200 m.a.	1000 watts	2.80
07-4	Grid Leak†	50,000 ohms	200 watts	60 m.a.	1000 watts	6.50
07-5	Grid Leak†	20,000 ohms	200 watts	100 m.a.	1000 watts	4.25
07-51	Grid Leak*	10,000 ohms	200 watts	135 m.a.	1000 watts	4.00
07-66	Grid Leak**	15,000 ohms	200 watts	120 m.a.	1000 watts	6.00
07-63	Rheostat†*	50 ohms	50 watts	1 amp.		5.50
07-59	Rheostat*†	20 ohms	80 watts	2 amp.		5.50
07-83	Rheostat*†	12.5 ohms	60 watts	2.2 amp.		5.50

Center-tapped
DeForest P or R. C. A. 852 Tube
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** Steps at 5M—10M—15M for R. C. A. 852 or DeForest P Tube
†* For Primary Control
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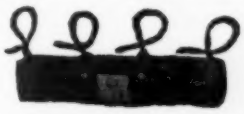

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15,000 ohm, tapped at 5,000 and 10,000 ohms with 85 watt capacity	Price, $1.50
20,000 ohms, 85 watt for UX852	1.50
5,000 ohms, 85 watts	1.00
5,000 ohms, 20 watt for one UX210	.75

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Perfected for your mercury arc. Absolutely no comparison with any other rectifier. Operates any tube at any power. New handbook says "The Arc Filters Beautifully." The plate power for your set you have always wanted—you can have it now. Your rectifier problems solved.

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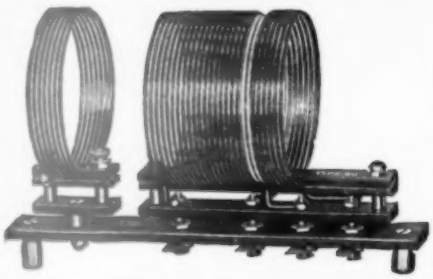

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20—40—80 Meter Band

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Chi-Rad Short Wave Coils Complete for 20, 40 and 80 meter band $10.00
Extra coil for broadcast band ..... $ 4.00

Dealers and Set-builders—write for further details and discounts.

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GUARANTEED—MOUNTED—COMPLETE

At Least 10% Cash Must Accompany Order

1 Kw.	2000-2500v	each side	$35.00
100 watt	350-550	each side	10.00
200 "	fil. trans 8 or 12 v		7.50
700 "	1000-1500 v	each side	15.75
700 "	2000-2500 v	each side	26.00
250 "	550-750 v	each side	12.00
250 "	25 cycle 600-800 v		16.00
700 "	25 cycle 1000-1500 v		22.00
700 "	25 cycle 2000-2500 v		28.00
200 "	25 cycle 8 or 11 v fil		11.00
30 Henry	150 mil	choke	10.00
50 Henry	150 mil	choke	12.00

9CES, F. GREBEN
1927 S. Peoria Street, Chicago, Ill.

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NEW LOW PRICES

Prices for grinding POWER CRYSTALS for use in the various Amateur bands as follows:

150-200 Meter band $13.00
75- 85.6 Meter band $22.00
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We state the frequency accurate to a tenth of one per-cent. Immediate deliveries, and all crystals guaranteed.

BROADCAST BAND

Prices for grinding crystals to your assigned frequency, accurate to PLUS OR MINUS 500 CYCLES are reduced to $45.00 UNMOUNTED, or $55.00 MOUNTED. Three day shipment, and all crystals guaranteed. In ordering please specify type of tube with which the crystal will be associated. Crystals ground to any frequency between 40 and 10,000 Kilo-cycles. Let us quote prices for your particular requirement.

SCIENTIFIC RADIO SERVICE
"THE CRYSTAL SPECIALISTS"
P. O. Box 86 Dept. V Mount Rainier, Maryland.

There are now 121 members and a repetition of all these calls will take up a lot of space and inclines one to just skip over them instead of really noting who they are. We are, therefore, listing the calls of the four additions since the appearance of the last roster. They are sb1AO, nu1CMF, foA4V and eg5YX.

The intermediate AG is assigned to Georgia, Armenia and Azerbaijan which are states of the U.S.S.R. They are in Europe and not in Asia as the intermediate indicates and it should be noted that contact with stations in these states cannot be accepted as Asian contacts in applications for WAC membership. They will be accepted only as European QSOs.

NEW ZEALAND

On page 72 of the November, 1927, *QST*, the mailing address of the New Zealand Association of Radio Transmitters was given as Box 733 whereas the correct address is P. O. Box 779, Auckland, New Zealand.

NEW ONES

aeAEP—P. Pah, Post Office No. 1, Bangkok, Siam. 36 meters, d.c. (7BB)

af8FOK—Rene Lebon, Section des Telegraphistes Coloniaux, Saigon, French Indo China. (8CFL)

ai2KT—Lieut. F. Rodman, The Worcestershire Regiment, c/o Lloyds Bank, Hornby Road, Bombay, India. (8CFL)

aq1MDZ—Sgt. J. H. Williams, R. A. F., Mosu, Iraq. (8CFL)

arOCOBK—Rev. G. H. J. Horan, Observatoire de Ksara, Saad-Nail pa Beyrout, Grand Liban, Syria. (8CFL)

ed7NI—Niels Jacobsen, Bredgade 29, Copenhagen, Denmark. (1CRA)

eg6AM—W. N. Doble, 1 Pickwick Rd., Dulwich, London S.E. 21, England. (8CFL)

eg6YL—(Miss) Barbara Dunn, Lilystone Hall, Stock, Essex, England.

eh9XC—Max Wuest, Bavanue des Tillevls, Lausanne, Switzerland. (2GX)

ei1BB—Francesco G. Leskovic, Udine, via C. Percoto, 6-2, Italy.

fe2VO—Cairo, Egypt. (1LX)

feEGEZ—A. Nahmias, 5 Rue Emad-el-Dine, Cairo, Egypt. (8CFL)

fk5CR—Sidney A. Pegrume, P. O. Box 23, Kenya Colony, British East Africa.

niTFHV—Dr. Hans J. Vogler, Akureyri, Iceland. 32 meters. (8CFL)

nm1NG—Apartado 511, Mexico City, Mexico.

nq2CF—Camp Columbia, Havana, Cuba.

nq5RY—Box 228, Matanzas, Cuba.

sh1MS—M. Solomon, Mackenzie City, Demerara River, British Guiana. (Will be used instead of sh6BR as given on page 46, August, 1927.)

sb2AL—Joao Levy Silva, 44 Rua Arthur Prado, Sao Paulo, Brazil.

California Man Has a Talk With MacMillan in the Arctic

LONG BEACH, Cal., Oct. 5 (AP). —Radio communication with the Donald B. MacMillan expedition in the Arctic was established here last night by Don C. Wallace, an amateur. Wallace picked up WMP, the MacMillan station, and exchanged numerous messages with G. E. Himoe, the expedition operator.

The expedition is preparing to dig in for the Winter, Himoe said. Snow began falling yesterday just as members of the party finished shingling the roof of their quar-

JERSEY AGAIN PICKS UP MACMILLAN WIRELESS

Expedition Now in Its Winter Quarters, Radio Operator Tells Absecon Amateur.

Special to The New York Times.

ATLANTIC CITY, N. J., Nov. 26.

A ten-minute conversation with the MacMillan Arctic expedition was reported by Emerson T. Showell, 20-year-old amateur radio operator, from Absecon today.

Showell was transmitting over a set of seven and one-half watts output, a twenty-meter wave length and and an inside aerial. He spoke with [illegible] Arctic Circle operator short

The MacMillan Expedition is equipped with "ESCO" Motor Generators.

ELECTRIC SPECIALTY COMPANY
Trade "ESCO" Mark
522 South Street — Stamford, Conn., U. S. A.

Makers of Motor Generators and Dynamotors with the least ripple and the most miles per watt.

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Build Satisfaction Into Your Set

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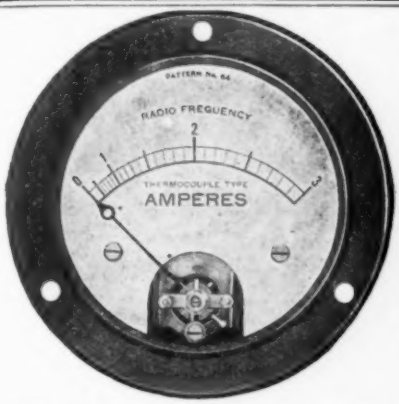
Most amateurs use Jewell instruments and they give unlimited satisfaction. They are properly designed and ruggedly constructed of best available materials, insuring high overload capacity with sustained accuracy.

Write for a copy of our Radio Instrument Catalog No. 15-C, which describes our instruments in detail.



Pattern No. 64 Radio Frequency Ammeter is a thermo couple type instrument with well known qualities of accuracy and high overload capacity. The loss in the instrument is less than one-half of the minimum required by the Navy, and the instrument is guaranteed to stand a 30% overload.

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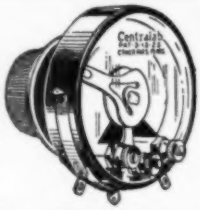

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Send for circuit literature.

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(Continued from Page 55)

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(Calls Heard from Nov. 19-Dec. 19.)

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2CMX, 240 Washington Avenue, Rutherford, New Jersey

(20-meter band)

4bl 4bn 4dm 4ei 4hz 4kw 4nd 4nl 4nn 4ob 4pq 4sb 4si 4st 4tk 4vz 4we 5fs 5hn 5gt 5pm 5ql 5yb 5afx 5akk 5aqe 5ara 5avs 5zav 6am 6ih 6uf 6vz 6ags 6anx 6ary 6avj 6che 6cqo 6csw 6cyh 6cyx 7bm 7fe nc-1ar nc-3gg nc-4ct nc-4fo nc-4fs nc-4fv nc-4gg nc-4hh eb-4au wnp.

et-TPAR, J. Ziembicki, Lwow, Bielowskiego 6, Poland

1akm 1mv 1awm 1fl 1xv 1alw 1acu 1bxl 1bgq 1si 1azd 1oa 1yb 1lv 1vz 1cek 1xi 1cjc 1cmf 1br 1ckp 1aj 1avl 2awf 2md 2nev 2amh 2abf 2ang 2avw 2amf 2crb 2tp 2ase 2bfm 2vp 2cxl 2ard 2dh 2bs 2bav 2bdu 2czr 2vm 2cty 2ow 3aiv 3ep 3sj 3alq 3aik 3etr 3bv 3aed 3rn 6am 8aul 8alu 8aut 8brd 8vd 8dad 8rv 9mx 9crj 9eld 9cjw ag-rann ai-2bg ai-2kt ai-2kw ai-2kx aq-1lm aq1mdz aq-1hf as-11ra as-35ra as-42ra fb-8fd ff-8ct fm-8st fm-8jo fm-8vx fm-al fm-8rit fo-o5t ea-aa ea-fk ea-gp ea-mm ea-py ea-sl ea-spo ea-tp ea-ty ea-tx ea-wg ea-wu eb-4ac eb-4ar eb-4ai eb-4au eb-4bc eb-4bl eb-4bt eb-4bu eb-4cb eb-4cd eb-4co eb-4cm eb-4db eb-4dj eb-4el eb-4em eb-4ft eb-4ht eb-4td eb-4uu eb-4zz eb-n33 ec-1rv ec-1kx ec-2un ec-2yd ed-7bl ed-7hi ed-7bb ed-7nd ed-7zg ee-ear1 ee-ear35 ee-ear40 ee-ear7 ef-8acj ef-8aro ef-8abc ef-8blr ef-8bw ef-8btr ef-8cp ef-8cq ef-8ck ef-8cn ef-8ctn ef-8cc ef-8ct ef-8dot ef-8dmf ef-8eo ef-8est ef-8fas ef-8fk ef-8fd ef-8flm ef-8fzx ef-8fbm ef-8dgb ef-8grg ef-8gi ef-8gyd ef-8hco ef-8he ef-8hip ef-8ix ef-8jmm ef-8jak ef-8kz ef-8ku ef-8kp ef-8kl ef-8kol ef-8ll ef-8la ef-8lb ef-8li ef-8lav ef-8mmp ef-8ma ef-8mop ef-8nno ef-8nox ef-8orm ef-8oqp ef-8olu ef-8pme ef-8prd ef-8pl ef-8pam ef-8pns ef-8rpu ef-8say ef-8sq ef-8ren ef-8tdo ef-8toy ef-8tra ef-8vx ef-8xf ef-8xu ef-8xo ef-8zed ef-8zb ef-8fnd eg-2cb eg-2ax eg-2dl eg-2nm eg-2zf eg-2so eg-2sc eg-2yu eg-2od eg-5ml eg-5qv eg-5ph eg-5yu eg-5yn eg-6bt eg-6gf eg-6rb eg-6yv eg-6pp eg-6ll eg-6by eg-6td eg-6hp gi-6mu eh-9xf ei-1ay ei-1au ei-1am ei-1bs ei-1bm ei-1ee ei-1cs ei-1cl ei-1er ei-1dm ei-1de ei-1dg ei-1dr ei-1db ei-1ed el-1eh ei-1ea ei-1fo ei-1gl ei-1gd ei-1kz ei-1mg ei1-no ei-1nm ei-1xw ej-1aa ek-4aar ek-4af ek-4au ek-4cb ek-4ck ek-4db ek-4dba ek-4fn ek-4hf ek-4hy ek-4oa ek-4uah ek-4ud ek-4uak ek-4uf ek-4vb ek-4vj ek-4vl ek-4yae ek-4yo ek-4xy ek-4zdf ek-afk el--la1x el-la1s el-lgn el-la1r el-la1l em-smuf em-smuk em-smuv em-smua em-smtm em-smtc em-smto em-smtn em-smvs em-smzy em-smzf en-obc en-oml en-2pz ep-1ag xep-1ma ep-3am er-5aa es-1co es-2naa es-2nx es-2nm es-5nk es-5dma es-fnd es-fnb etp-ach etp-bb etp-bn etp-om etp-tz etp-zo eu-6ra eu-o9ra eu-15ra eu-20ra ew-xx nc-1ac nc-2bc nc-2do ne-sac

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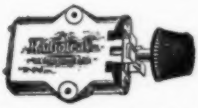

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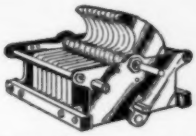

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nl-gren nt-c5eck oa-2yj oa-2ms oa-3xo oa-few op-1hr oz-1an oz-1fb oz-2ab oz2bp oz-2ax oz-2at oz-2ay oz-2gg oz-2go oz-2ga oz-2gg oz-3au oz-3ap oz-4am sa-lp1 sa-de3 sb-law sb-lah sb-lao sb-lak sb-laq sb-1br sb-1ca sb-1cl sb-1br sb-1ic sb-2al sb-2ag sb-2ay su-1ja su-1bu.

eg-2BQH, G. G. E. Bennett, 26 Blenheim Park Road, Croydon, Surrey, England

1aba 1abd 1abs 1age 1aja 1ajx 1akx 1akm 1alu 1amd 1anx 1aom 1apo 1aq 1aqp 1asf 1aur 1ava 1avj 1axa 1azd 1bat 1bbc 1bbo 1bdx 1bed 1bgq 1bik 1bke 1bkp 1bl 1bms 1bux 1caa 1chg 1cjc 1cjk 1cmf 1cmp 1cmx 1cmz 1cnz 1ctp 1cx 1fl 1gj 1ka 1kr 1mp 1mv 1lp 1lv 1mo 1si 1sk 1sz 1uo 1vp 1vs 1vz 1xv 1yb 1zz 2aad 2ach 2acz 2aed 2afr 2afv 2ag 2agp 2agw 2ahi 2aib 2alu 2ang 2ani 2apd 2aqb 2aqu 2ass 2atq 2awk 2ayj 2az 2bao 2bbc 2bbf 2bbj 2bbx 2bdc 2bdh 2bed 2bfj 2bfv 2bfw 2bgo 2bi 2bot 2bow 2bs 2bsc 2bum 2bxu 2cdm 2cmu 2cp 2cs 2ctf 2ctm 2ctn 2cuq 2cvj 2dh 2do 2dp 2fx 2gp 2hu 2ie 2uo 2vm 2xam 2xbc 2xg 2xs 2za 3adp 3afw 3ag 2ih 2iz 2kg 2lh 2or 2ov 2pn 2ps 2tr 2tm 2uh 2ui 3aib 3aks 3amm 3anh 3apn 3aqx 3bh 3bjh 3bnu 3bph 3bp[5] 3bqj 3bqp 3bqz 3bsd 3cab 3cbt 3ce 3chg 3ck 3ckj 3ckl 3gp 3ht 3ld 3lw 3nr 3pf 3pr 3pg 3qe 3sz 3un 3wm 4abc 4acv 4adb 4be 4gy 4hx 4jw 4lk 4lp 4mk 4nu 4on 4oo 4qe 4rn 4rp 4rq 4wn 4xe 5ank 5aot 5api 5asm 5atf 5aur 5auz 5av 5fb 5kc 5kd 5nw 5rd 5xm 6aak 6agr 6am 6amn 6ann 6app 6aws 6awt 6bfl 6bgx 6bjl 6bkd 6bmp 6bpc 6bwr 6bxi 6byz 6bzn 6cqi 6ct 6cto 6cwj 6cww 6dan 6dev 6dgy 6dhj 6djw 6dlj 6dor 6dpj 6dxu 6ec 6fh 6hc 6ix 6ja 6jn 6mu 6pw 6rn 6xi 8abx 8adg 8agk 8agy 8aks 8akz 8alo 8ane 8aro 8asf 8aug 8avp 8awu 8axa 8bau 8baz 8bdt 8bja 8bjb 8bjx 8bok 8bou 8bqo 8bsr 8bwr 8bwv 8bww 8byn 8bzc 8ccm 8cer 8ces 8cjb 8ckc 8clp 8cnj 8cnt 8cnx 8cpf 8cpc 8cvj 8dan 8dbe 8dbm 8dcg 8dcm 8ded 8dfw 3dko 8dkk 8dqk 8dtp 8eq 8ex 8it 8jg 8kj 8li 8nn 8pl 8rh 8ru 8vd 8wo 8xe 8zzc 9aal 9abk 9ahc 9ahz 9aof 9aon 9aop 9apv 9ars 9aue 9axz 9azq 9baf 9baz 9bbm 9bbr 9bbw 9bcj 9beq 9bif 9bjw 9bl 9bmm 9bpw 9cdi 9ceb 9cfd 9cjh 9cjw 9cm 9cmj 9cmv 9cn 9cph 9cpq 9cpr 9crd 9cty 9cv 9cvu 9cyp 9dbi 9dbj 9des 9dfj 9dfz 9dga 9dkk 9dpj 9dpn 9dws 9ebw 9ecz 9ef 9efc 9efz 9eld 9emu 9enp 9eox 9fo 9fs 9iz 9rp 9rv 9uu 9uy 9wr 9xi naa wnp ncl-ak nc-1br nc-3cs nc-3mf nc-3z8 nc-9bj ng-uf nn-1nic sb-1aw sb-pty sa-1pl ac-8na nc-xom naa wnp nc-1ak nc-1br nc-3cs nc-3mf nc-3z8 nc-9bj as-35rn au-rabs aq-1mdz fo-a3z fo-aqa fm-8rit oa-2dy oa-2rc oa-2ro oa-2yi oa-3gr oa-7cw oa-7hl oa-7lj oh-6xo oz-1aj oz-1fb oz-1fe oz-2av oz-2bp oz-2go oz-3ap oz-3ar oz-3aw oz-4nc oz-4ne oz-4bc.

eg-2HJ, K. E. Brian Jay, 19 Elm Close, Amersham, Bucks, England

(20-meters)

1asr 1awe 1caw 1cmf 1cmx 1fl 1sz 1wz 1xf 2ag 2agn 2anm 2aol 2bad 2cuq 2dr 2gq 2jn 2md 3adm 3ahr 3vg 5zav 8ahc 8aht 8arb 8ayu 8bag 8bde 8buo 8cjm 8dbc 8dcl 8djv 8dkx 8dmz 9afa fo-a3z nc-1ad nc-1bt nc-3cs ne-8wg np-4sa wnp

(40-meters)

1abd 1aeg 1age 1ais 1aqj 1axm 1bft 1cd 1cty 1hn 1mo 1mx 1ro 1ut 1vs 2abf 2adl 2aed 2afr 2ahg 2alr 2amh 2aoj 2awk 2bdj 2bgb 2buz 2bvh 2crn 2dp 2ev 2gp 2jc 2kp 2vp 2wz 3afw 3ahp 3aib 3apn 3auw 3bqz 3bsd 3cdg 3ckj 3dq 3ec 3jr 3ke 3pe 3pr 3qe 3qt 3sz 4aby 4ao 4bl 4df 4gq 4nq 4oo 4qw 4qz 4rm 4rn 4vr 5api 5aqf 5atf 5atv 5auz 5jd 5kn 5la 5qq 5vf 5we 5yb 5zav 6ary 6bfp 6dkx 6eb 6rn 8abx 8aet 8age 8ajy 8bat 8baz 8bdw 8bek 8bm 8cde 8ceh 8cer 8cym 8dbc 8dce 8dfw 8dmm 8dne 8dqb 8dsa 9abz 9acl 9adk 9aok 9bmm 9bnb 9bpl 9brn 9ceb 9cej 9cia 9cmv 9cn 9cpq 9cpu 9crd 9evn 9cyp 9czw 9dbi 9dbj 9dbw 9dce 9dck 9dej 9dge 9dkc 9dku 9dmj 9drd 9dwa 9dws 9dxp 9ecz 9ef 9efz 9egn 9emr 9pd 9rd 9uz 9xi fm-oveit fo-a9n nc-2an nc-2be nc-3kp nc-4cm nc-4du ne-8ae nq-5by xnh-2vq oa-3ks oa-3ot oa-5by oa-7ch oa-7pf oh-6buc op-1cw op-1hr oz-1fe oz-2ae oz-2at oz-3ai oz-4ae oz-4am sb-1ac sb-1ad sb-1ib aqe nu-abl gmd lgn wnp wpo.

eg-6BB, 31, Court Lane, Dulwish, London, S. E. 21, England

1awe 1aq 1adu 1xv 1bux 1bkp 1ajv 1asf 1ahv 1bms 1bke 1aae 1akx 1ckp 1aqt 1ctp 1akz 1ajz 1bqt 1ne 1rf 1ah 1wl 1cd 1ask 1bob 1acm 1cio 1asu 1bak 1ho

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Hartford, Conn.

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Street & No. Place State

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2tp 2vc 2ov 2aqb 2rs 2ow 2crb 2agn 2mk 2bfq 2qu 2md 2bv 2axt 2az 2bhc 2sm 2apy 2tru 2gp 2jp 2avq 2ct 2evj 2czr 2bck 2bav 2bdh 2azk 2cub 2anv 2bnu 2ws 2adb 3aed 3aim 3uk 3aib 3bjy 3hg 3bkw 3ag 3bnu 3ckj 3buv 3sz 3pf 3amx 3hu 3tm 3amw 3vi 4tk 4ev 4rr 4qb 4oc 4qz 4bl 4pac 4bn 4eu 4dv 4rn 4ec 5ek 5we 6xi 8dmz 8jbb 8bto 8do 8gz 8az 8im 8ckc 8elp 8etl 8dne 8bal 8bpa 8pi 9epq 9emj 9eag 9crd 9baz 9crj nb-be3 nc-1ar nc-3ay nc-3gz sb-1br sb-1ea sb-1bg sb-1am sb-2aj op-1ya oa-5hg oa-7cw oz-2me oz-3aj oz-3au oz-3bq oz-4aa wuo.

BRS-90, W. F. B. Shaw, 198 Abington Ave., Northampton, England

1aae 1abd 1abs 1aep 1ajm 1akz 1ale 1aof 1aow 1awe 1ary 1bae 1bms 1bw 1cd 1cbr 1cmp 1cnz 1cpb 1fs 1ga 1ja 1no 1nl 1pa 1qb 1vc 1xv 1yb 2aad 2abe 2afr 2agn 2agp 2agw 2ahi 2alu 2amf 2amj 2aqb 2awf 2bfj 2bfq 2bg 2bgt 2bm 2bo 2crb 2exl 2czr 2ev 2hr 2jn 2md 2ov 2ow 2pn 2rs 2tp 2vm 3abo 3adm 3aed 3ag 3aim 3alq 3bqz 3dh 3ec 3fw 3ld 3lw 3qe 3sj 3ud 3uk 3wm 4ei 5yb 8adg 8adm 2ahk 8bsu 8cau 8ccw 8den 8oq 9deq nc-1ak nc-1bh nc-1br nc-2bg.

eb-4CB, Ostend, Belgium
(20-meters)

1ajm 1bux 1de 1bw 1asr 1asf 1aje 1ch 1acm 1cd 1axa 1aep 1cv 1bms 1wz 1cbt 1ajo 1fl 1byv 1cmx 1cmf 1rd 1ga 1xv 2agn 2aol 2bgc 2bum 2awf 2va 2bim 2cuq 2nr 2arm 2afx 2fv 3aib 3vg 3cv 3adm 3gv 3ckz 3bqz 3ckj 3cfg 3qe 6am 8com 8jm 8jq 8acu 8dne 8axa 8ahc 8bcm 8ail 8azo 8bbm 8dhp 8ady 8cuq 8adz 8aly 8djv 9pm 9auu 9civ 9efz 9ek nc-1ao nc-1ar nc-1br nc-3bt ne-8af fo-a8p fo-a4f fo-a8z fi-1b wnp.

eb-4KD, A. Blancquaert, Rome St., Lokeren, Belgium

1bqt 1cd 1di 1xd 1asf 1lc 1ang 1adb 1cnx 1bkl 1afl 1ask 1ads 1ok 2bfg 2aar 2bew 2aoo 2dd 2ba 2md 2vt 2rs 2agn 2aqo 2cjb 2ps 2tp 2ncd 2xad 2ws 2ahg 3ev 3aib 3alr 3kv 3gi 3rfg 3amx 3aim 3afx 4ei 4vx 4ck 4ec 4tk 4rb 5yb 8ayu 8anh 8dne 8cvs 8baz 8ake.

ef-RO91, C. Conte, 24, Allee Du Rocher, Clichy-sous-Bois, France

1abz 1adb 1afl 1ajg 1ajx 1amu 1aod 1aqm 1aqp 1aqt 1asf 1avj 1awe 1bc 1bdq 1bke 1br 1bux 1ck 1ckp 1cmf 1dk 1fs 1hd 1id 1lc 1no 1qa 1rf 1sx 1sz 1yc 2abp 2afa 2agw 2alu 2amf 2amj 2ang 2apd 2apx 2as 2asa 2atq 2axk 2bbc 2bck 2bco 2bcq 2bcw 2bdh 2bew 2bgt 2bir 2bt 2cub 2cuf 2cuq 2czr 2di 2ff 2kr 2md 2qv 2tp 2uo 2vq 2wh 2xad 3afx 3aih 3ajd 3akv 3amx 3apx 3ani 3big 3bnu 3bqz 3cdq 3ec 3fw 3gp 3kt 3pf 3qw 3rb 3sz 3vf 3vx 4aby 4acz 4jm 4lk 4nu 4ob 4oo 4qz 4rn 4rq 4sq 4ux 5aao 5auz 5ayl 5gr 5jc 5uv 5we 8alf 8bek 8bhz 8bni 8brh 8bni 8cew 8cke 8dcm 8dhx 8dnf 8dod 8qp 8uy 8vv 9aid 9aok 9ayr 9apv 9baz 9edw 9epr 9crd 9eue 9cya 9dli 9dpw 9dsz 9eag 9ekw 9ell 9mz 9etd nc-2ax nc-3dz nn-1nic nr-2fg wnp vpw.

Curtis Steed, U. S. S. *Smith Thompson*, 212 Casablanca, Africa & Ville-franche, France

1cmf 1bdm 1is 1axx 1aba 1ck 1cmx 1asi 1ctn 1ga 1br 1avh 1bkp 1ej 1bqs 1cl 1ak 2cxl 2ki 2crb 2kr 2dh 2tp 2cvx 2beo 2ag 2ev 2aqb 2ea 2ctm 2ase 2uo 3gp 3qw 3fw 3cb 3dk 3ckl 3aic 3wm 3jl 4auk 4rn 5yb 5ni 8ajt 8xet 8ckc 8gn 8dne 8amu 8adg 8wt 8gk 9cn 9crd kfzg.

5PM, J. Allen Swanson, Jr., 7103 Freret St., New Orleans, La.

(Heard between Dec. 27 and Jan. 14)

1ano 1aap 1aed 1aoo 1avw 1bbx 1ctp 1if 1qa 1rp 1rr 1si 1yb 1yd 2afw 2alu 2aqu 2asi 2aub 2axy 2bda 2bex 2ff 2bk 2cx 2di 2hc 2kk 2kx 2xaf 3aib 3arb 3bnu 3bph 3bsd 3dq 3hg 3pp 3qe 3qt 3ra 4abj 4acv 4adb 4bn 4bu 4dv 4ei 4fd 4ff 4oc 4uo 5aa 5acu 5adp 5ama 5aqc 5aqw 5ase 5atp 5ava 5avw 5awl 5gr 5ih 5lu 5lv 5mq 5rq 5si 5sy 5tb 5tc 5te 5uk 5ut 5uw 5yw 6bdl 6bq 6dz 6eis 6dbc 6vu 6rb 7ok 7hu 7ti 7wv 7wx 8afu 8alu 8amu 8asn 8atv 8avg 8nxh 8bfa 8bhp 8ded 8dqm 8li 8lx 8vf 8vx 9ama 9avr 9bwv 9bdw 9bcd 9blu 9bqa 9dfk 9crp 9cua 9dkk 9dod 9dzp 9eao 9ep 9hb 9hf 9su 9ww 9xi abi oa-5wa oa-5hg oa-5dx oa-1am sb-1ab sb-1ao sb-2ar sc-1as nc-3bk nc-4cp nc-3cb nr-2fg nq-2bt nq-2ro nq-5by nd-hik eq-2kk eg-5ly nm-1g nm-1a nn-1nic fw-9bk glk.

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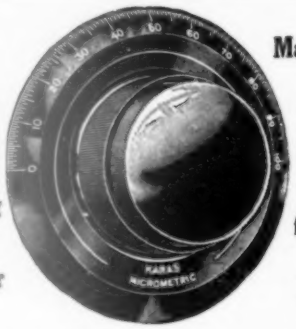

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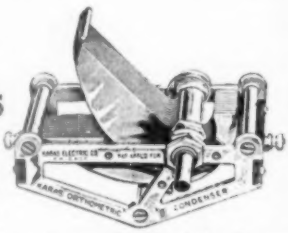

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5ZAV, Le Roy Moffett, Jr., 223 East Fourth St., Oklahoma City, Okla.

ef-8cp ef-8fd ef-8ix ef-8jf ef-8vvd en-0ja ep-1ae fc-2xr fq-pm fm-8ma fm-8st nc-1aa nc-1ap nc-1co nc-2be nd-hik nm-9a nm-9b nn-1nic nn-2nic nq-2ac nq-2ef nq-2jt nq-5ev nq-5nin nq-5ry nq-7cx nr-cto nr-2ea nr-2fg oa-1rx oa-2dy oa-2ij oa-2rb oa-2rx oa-2xi oa-2yi oa-2yj oa-3es oa-31s oa-3pm oa-3vp oa-3xk oa-4cg oa-4nw oa-5ax oa-5bg oa-5dx oa-5hg oa-7bq oa-7cw oa-7hl oi-btta oo-cnlf oo-bam oh-6dpp oh-6dlr oz-1ao oz-1fe oz-1fs oz-2ae oz-2ay oz-2bg oz-2ga oz-3aj oz-3ar oz-3au oz-4am sa-cb8 sa-da8 sa-1aa sb-1ac sb-1ah sb-1ak sb-1ar sb-1aw sb-1br sb-1cg sb-1ib sb-1ic sb-2ag sb-2aj sb-2ak sb-2ar sb-2ax sb-2ay sb-2ig sb-2xi sc-2ar sc-2bl sc-3ag se-1fg su-1cd su-2ak sv-1xc aqe arcx ardi de-dra doj cfzq famp oic oik wnp xen-0qq wye 0sq xnu-1xl x-sk xem-sfv.

8AXA, C. B. Hoag, 123 E. Matson Ave., Syracuse, N. Y.

eb-4au eb-4cb eb-4tm ed-7cz ee-ear10 ef-8ba ef-8btr ef-8cp ef-8ef ef-8fd ef-8px ef-8toy eg-2ao eg-2bm eg-dn eg-2nh eg-2od eg-2am eg-2vq eg-5by eg-5hs eg-5ku eg-5ls eg-5ma eg-5ml eg-5ms eg-5yk eg-5yx eg-6fz eg-6jv eg-6rb eg-6za eg-6wl ei-1bs ek-4aap eo-1gw eo-11d eo-17c ep-1aa ep-1ai nb-be3 ni-1ag nn-1nic nn-2nic nq-2jt nq-5ry nq-7cx nr-2ea nr-2fg nx-1xl sb-1ad sb-1ah sb-1al sb-1cg sb-1ct sb-2aj sb-2ax sb-2id sb-2ig sb-5aa sc-2bo oa-2sh oa-3jk oa-5bg oa-5cm oa-5mb oz-3ai pot.

8CDB, Bob Wood, 860 Maryland Ave., Syracuse, N. Y.

6aat 6ann 6abk 6am 6aqw 6akw 6app 6atu 6adm 6bq 6bec 6baj 6bjl 6bjq 6bsn 6bjh 6bxr 6czm 6cmq 6dib 6ahm 6dog 6dhb 6dfq 6dg 6fh 6rn 6zbe 7aat 7aka 7am 7agb 7akq 7ach 7aer 7afm 7ab 7fe 7fi 7il 7iv 7if 7hb 7lf 7ti 7tw 7mo 7ob 7vf 7vz eg-2bm eg-5by eg-5hs eg-5ma eg-5ml eg-5wq eg-5yk eg-5yx eg-5rb eg-6rb eg-6vp gi-2it gi-6mu gc-5yg gc-5gz eb-4au eb-4cb eb-p1 ef-8aqm ef-8btr ef-8btx ef-8eo ef-8est ef-8fiz ef-8orm ef-8toy ep-1ai ep-1ap xep-1ma ei-1gl ek-4aap eu-1auf oa-3es oa-5dx oa-5mb oa-5wh oa-5wg oz-4am aj-4zz aq-1mdz aq-1lm fo-a3m fo-a3v fo-a3z fo-a4b fo-a4x fo-a9a fq-pm fm-8mb sb-1ab sb-1ah sb-1aw sb-1ca sb-2aj sb-2ib sb-2ig su-2ak nb-be3 nl-gren nn-1nic nm-8a nm-9a nc-5ef nx-1xl rjc j2 nr-2fg nq-2cf nq-7cx.

8CRG, L. Solak, 1072 Milan Ave., Amherst, Ohio

(20 meters)

1cmf 1afl 1bbm 1byv 1asf 1afl 1bge 5akp 5auw 6dev nc-4fv nc-4gg.

(30-50 meters)

6xi 6bvm 6cdw 6aat 6bau 6wr 6ac 6atu 6biu 6czk 6ns 6bzf 6bih 6buv 6abp 6brq 6bgl 6dgu 6ec 6dom 6arw 6bco 6dog 6bq 6bhv 7bb 7fe 7afv 7gf 7vj 7acj 7mx nc-4ha nc-4hh nc-4fh nc-4op nc-4ek nc-5cj sb-1ak sb-1ah sb-1ax sb-1bg sb-1aw sb-1ao sb-1cg sb-1cm sb-1aq sb-2ar sb-2al sb-2ig sb-7aa sc-2as sh-8lb nr-2fg nn-1nic ny-1xc nm-1n nm-xc51 nm-xc55 nq-2jt nq-2la nq-5ry nq-5by nq-2ua nq-vg nv-adg ne-8ae ne-8fd ep-1aa ef-8orm ef-8ct ef-8oqp ef-8dmf ef-8fd ef-8vvd ef-8bc eb-4oi eb-4au ei-1fp ee-ear48 eg-2nh oa-2dy oa-4nw oa-3cp.

8JQ, 2711 Espy Avenue, Dormont, Pittsburgh, Penn.

sa-aa1 sa-da8 sa-da9 sa-en8 sa-fc6 sa-fh4 oa-2dy oa-2hm oa-2jw oa-2rb oa-2ro oa-2rt oa-2rx oa-2sh oa-2tm oa-2xi oa-2yi oa-3al oa-3bq oa-3es oa-3ks oa-3jo oa-3ot oa-3wm oa-3xo oa-4ae oa-4bd oa-5bg oa-5bw ou-5da ou-5hg oa-5wh oa-7ch oa-7cw oa-7lj vis. ea-cm ea-cr ea-gp ea-spo eb-4ac eb-4au eb-4bc eb-4cb eb-4ck eb-4co eb-4ww eb-4zz eb-p1 sb-1aa sb-1ac sb-1ad sb-1ah sb-1aj sb-1ak sb-1al sb-1ao sb-1ap sb-1aq sb-1ar sb-1au sb-1aw sb-1ax sb-1bg sb-1bl sb-1br sb-1ca sb-1cd sb-1cg sb-1cl sb-1co sb-2ab sb-2ag sb-2aj sb-2ak sb-2al sb-2ar sb-2au sb-2ax sb-2az sb-2bf sb-2ie sb-2ig sb-1ia sb-1ib sb-5aa sb-6aa sb-6qa sb-7aa sb-7ab fq-pm sc-2ar sc-2as sc-3ag sr-2ea nr-2fg nr-2gph nr-cto nq-2ac nq-2cf nq-2jt nq-2bo nq-2la nq-5nin nq-5ry nq-7cx nq-8en nq-8xp ed-7fr nd-hik se-1fg fe-2vo ef-8ba ef-8cp ef-8ct ef-8ef ef-8eo ef-8er ef-efd ef-8fr ef-8ix ef-8jf ef-8jz ef-8xo ef-8btr ef-8dmf ef-8est ef-8dgb ef-8oqp ef-8orm ef-8vvd ef-8ycc ek-4aap ek-4dba ek-4uf ek-4yo ek-aeq eg-2bm eg-2dn eg-2it eg-2s. eg-5by eg-5jw eg-5ls eg-5ma eg-5ml eg-5mq eg-5ms eg-5oc eg-5wq eg-5yk eg-5yx eg-6fz eg-6ia eg-6oh eg-6rb eg-6uh eg-6yq

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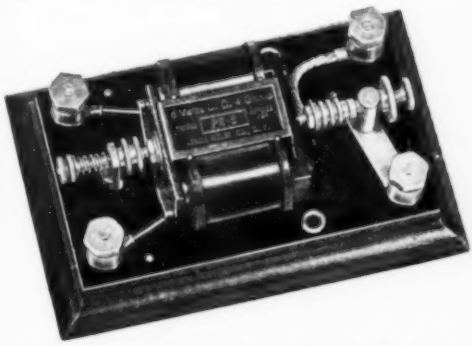

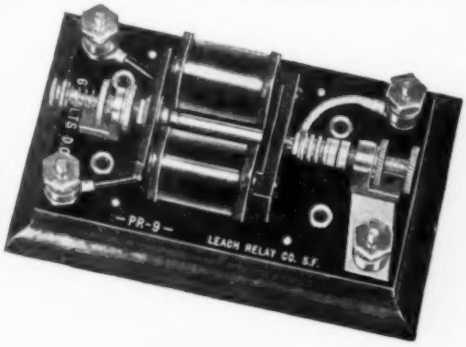

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eq-6yv ng-uf gw-17c ei-1ay ei-1dm ei-1er nl-gren fl-1ab ep-1ag ep-1ai ep-3am ep-3fz ep-3gb nm-1g nm-1j nm-9a nm-9b nm-xc11 fm-8ev fm-8est fm-8psrv en-oga en-oja oz-1ao oz-1ap oz-1fb oz-1fe oz-2ac oz-2ae oz-2ay oz-2bp oz-2bu oz-2ga oz-2go oz-2rb oz-2xa oz-3ai oz-3aj oz-3ap oz-3ar oz-3au oz-4am oz-4ar nn-1nic ns-3jg fo-a3c fo-a3v fo-a3z fo-a4x fo-a8p ee-ear65 oo-bam su-2ak sv-1xc.

9BCA, 308 7th St., Fort Madison, Ia.

nq-2jt nq-2ro nq-5ev nq-5nin nq-5ry nq-7ex nn-1nic nm-1g nm-1j nm-1r nm-9a nm-9b nr-2fg nr-2ea nr-cto oo-bam oo-geo fq-pm oa-2re oa-3ew oa-3jk oa-3kw oa-5mb oa-5hg oz-1ao oz-2ab oz-2ay oz-2ga oz-2me oz-3am oz-3ai oz-3aj oz-3au oz-3ap oh-6dqq sb-1ah sb-1cg sb-1ao sb-1br sb-1ca sb-1bv sb-1aw sb-1ao sb-1ak sb-1ac sb-1bg sb-2ak sb-2aj sb-2ay sb-2ag sb-2ig sb-2ih sb-2ax sa-hg9 sa-dw4 sc-2bl tqw.

9ECZ, H. E. Niece, Niota, Illinois

ef-8xo ep-8cp nq-2ac nq-2cf nq-5by nq-5ry nr-2fg oa-2dy oa-2hm oa-2ij oa-2ms oa-2nj oa-2rb oa-2re oa-2rt oa-2rx oa-2sh oa-2ss oa-2ui oa-2xi oa-2yi oa-3ar oa-3es oa-3jk oa-3jo oa-3kw oa-3ro oa-3vr oa-3wg oa-3wm oa-4aa oa-4bd oa-4cg oa-4cm oa-4go oa-4nm oa-5bg oa-5cm oa-5da oa-5hg oa-5mb oa-5mx oa-5wh oa-5ws oa-5xg oa-6mu oa-7bq oa-7ch oa-7cw oo-bam oz-1aa oz-1aj oz-1ao oz-1ap oz-1fe oz-1fq oz-2ae oz-2at oz-2bp oz-2go oz-2me oz-2xa oz-3ai oz-3ap oz-3au oz-4ac oz-4ae oz-4am oz-4xe sa-cb8 sb-1ea sb-1ib sb-6qa arcy arex.

Arnold King, Jr., 7300 Champlain Ave., Chicago, Ill.
(40 meters)

nl-5aa nm-9a nm-cyy nn-1nic nd-hik nq-5ry nq-5ev nq-7cx nq-2cf nq-2ro nq-2jt nq-2ja nr-1ur nr-2fg nr-2ea nq-2ac nx-1xl ef-8ix ei-1no ei-1cr ep-3ag ep-3fz ek-aeq es-1co fq-pm fl-1ab sa-cb8 sa-da9 sb-1ao sb-1ak sb-1aw sb-1ah sb-2al sb-7ab sb-1cg sb-1ic sb-1ca sb-1ib sb-2ay sb-1bg sb-2aj sb-2ag sb-2ig sb-1cl sb-1al sb-1ax sb-1ar sb-2ax sb-sqax sc-2bl sc-2as xoa-5ma oa-6mu oa-2rx oa-2dy oa-4cg oa-2rb oa-5hg oa-5wh oa-7ch oz-2go.

9BCF, Elmer A. Gunther, 514 11th Ave. So., Ft. Dodge, Iowa

sb-1ag sb-1ah sb-1ak sb-1ar sb-1aw sb-1be sb-1ca sb-1cg sb-1fb sb-2af sb-2ak sb-2aj sb-2ig sb-snm sc-2ab sc-2ar sc-2as sc-2aq sc-2bi se-1fg su-2ak xen-0sq nm-1a nm-1a nm-1e nm-1g nm-1ia nm-1n nm-1j nm-2rz nm-2cc nm-9a nz-ez5 nq-2ac nq-2cf nq-2jt nq-2rm nq-5ev nq-5ry nq-7cx nq-8kp nq-3yp nq-4sa nj-2ps nj-2yp nj-1fq nl-4x nl-5aa nn-1nic nn-m3y nr-2fg nt-2rg nr-cto nr-oik ff-jp oh-6ajl oz-2ae oz-2ae oz-1oa oo-mba oa-2ec oa-2hm oa-2mc oa-2mh oz-2no oa-2sd oa-2sb oa-2sg oa-2rx oa-2yi oa-3ai oa-3bc oa-3vp oa-3my oa-5ax oa-5bc oa-5ch oa-7hv xc51 xsa-bvs wge wvx ww wnp wnbt wuby know nitc kivf vde ardi ug ks voq.

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